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MICHIGAN PUBLIC SERVICE COMMISSION
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Readying Michigan to Make Good Energy Decisions: Energy Efficiency

DRAFT

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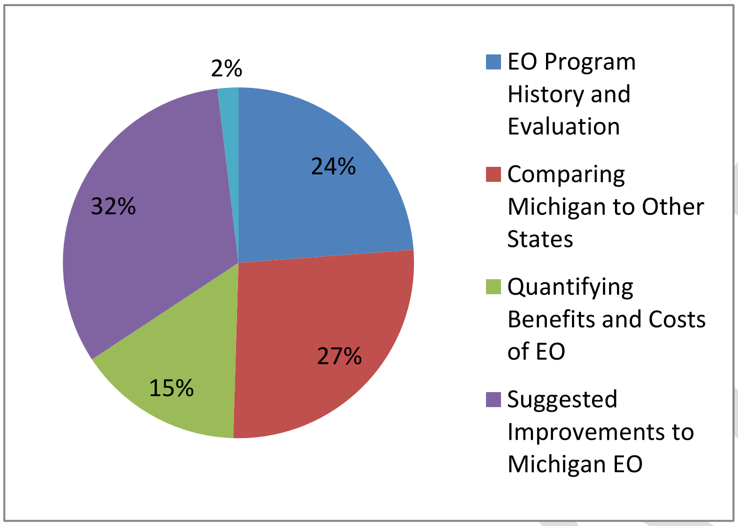
In addition to NRRI, Synapse Energy Economics assisted by providing information regarding possible methods for evaluating the economic impacts of efficiency programs. Additional support was received from Optimal Energy through an extension of an existing grant with the MPSC, to perform an economic analysis and to create options for energy efficiency in Michigan based upon Michigan's energy efficiency potential.

Readying Michigan to Make Good Energy Decisions – Energy Efficiency Executive Summary

The 30 energy efficiency questions posted on the Ensuring Michigan's Energy Future website garnered 87 responses. The comment summary pie chart presents an overview of comments received at the website. Many additional comments regarding energy efficiency were provided at the public energy forums.



Where Michigan Is Today: Michigan's current Energy Optimization (EO) standard required electric providers to ramp up energy savings to 1.0% of the previous year's electricity sales in 2012, and natural gas utilities to ramp up energy savings to 0.75% of the previous year's sales in 2012. The provisions in PA 295 provide for the continuation of the 1.0% energy savings for electric providers and 0.75% energy savings for natural gas providers through 2015. Beyond 2015, the efficiency savings targets would remain at 2015 levels under Michigan's current law. Michigan's electric and gas utilities are, in aggregate, surpassing the standards set forth in PA 295. Natural gas utilities achieved 134% of their targets in 2011, while electric utilities achieved 116% of their targets in 2011. Initial results for 2012 also indicate the targets were met, with natural gas utilities achieving 126% of their targets, and electric utilities achieving 125% of their targets. For each dollar spent on utility EO programs during 2012, it is estimated that customers benefit from approximately $3.83 in avoided energy costs (on a net present value basis). The total estimated savings for the 2012 program year is expected to reach $936 million on a net present value basis, and for the 2013 through 2015 program years, an additional savings of $2.8 billion is expected. Through 2011, Michigan consumers paid approximately $408 million in support of EO programs. Program spending for 2012 was $245 million, and program spending for 2013, 2014 and 2015 is expected to be about the same level as for 2012.

<u>EO Program History and Evaluation</u>

- Michigan utilities are on track to continue to meet the current EO targets.
- Utility EO programs are designed to encourage customers to make their homes or businesses more energy efficient. Utilities collect money from customers in the form of a surcharge on the customers' bills to fund the EO programs. The programs typically include rebates or incentives to reduce the upfront cost of energy efficiency upgrades such as lighting, furnaces and insulation.
- The objectives of the utility EO programs include delaying the need for new electricity generation, reducing emissions, encouraging local job creation, and lowering customers' utility bills.

- Commenters state that Michigan's EO programs to date have been cost effective.
- PA 295 provides that Michigan EO spending shall have a cap, not to exceed 2% of each utility's annual revenues. The cap provides an incentive for utilities to pursue the most cost-effective EO programs to achieve the energy savings targets.
- EO charges collected from a particular customer class, such as residential, commercial, industrial or low-income, must be spent within that same rate class.
- PA 295 contains provisions allowing non-residential customers to self-direct their own EO programs. Self-directed EO programs are self-funded, and self-directed EO program customers do not pay EO surcharges to the utility. Self-directed EO programs have only been implemented by a handful of large customers.
- Commenters agree that energy efficiency should be considered a resource in long-term utility planning, however, caution was expressed that future savings are likely to be more expensive to achieve than in the past, because many cost-effective EO programs have already been implemented. Estimates of the increased cost of future programming are included in the GDS Potential Study and further evaluated by Optimal Energy.

<u>Comparing Michigan EO Programs to Other States</u>

- Many differences exist between state energy efficiency programs related to targets, timing, funding, and applicability making it difficult to directly compare programs between various states.
- Six states have standards that are 2.0% of electric sales or higher and nine (including Michigan) have standards between 1.0% and 1.9%.
- Five of nine states have natural gas standards above 1.0% and three of nine (including Michigan) have standards between 0.5% and 0.9%.
- State standards generally allow a broad range of end-use efficiency programs to count, but differ on whether to include combined heat and power, applications of waste heat, reduced transmission and distribution line losses, and electric generator efficiency upgrades.

<u>Identifying and Quantifying Benefits and Costs of EO</u>

- Benefit-cost tests are typically used to evaluate EO programs. Michigan law requires the utilities to use the utility system resource cost test (USRCT) sometimes referred to as the utility cost test (UCT), or the Program Administrator Cost (PAC) test. The USRCT includes all of the costs and benefits experienced by the utility.
- Some commenters contend that the USRCT does not take into account other benefits that were identified by commenters such as environmental improvement, macro-economic growth, or societal benefits.
- The USRCT also does not take into account costs experienced outside of the utility, such as the customer's investment in new energy efficient equipment such as an upgraded furnace or insulation.

- Energy efficiency could also be used to prevent local reliability problems through geo-targeting.
- Utilizing the USRCT for calculating the benefits and costs synchs up well with revenue requirement (rate making) considerations.
- The report outlines additional methods for identifying and quantifying the benefits of EO programs.
- Michigan is one of the few states that relies on the USRCT (Utility System Resource Cost Test), also known as the Program Administrator Cost (PAC) test, as its primary test. Only one of the eight states surveyed for this report, and five states throughout the United States, use the PAC test as their primary test.

<u>Improving Michigan's EO Programs</u>

- Nearly one quarter of the comments submitted included alternatives for improving Michigan's EO programs.
- Suggested improvements include adding the following specific devices and emerging technologies in utility EO programs:
    - Flue-gas heat recovery systems
    - Combined heat and power systems
    - Geothermal heat pumps
- Additional alternatives for improving Michigan's EO programs included:
    - Providing customers with more detailed and timely data to better tailor their energy use to reflect utility system costs that vary in response to the timing of customer demands.
    - Upgrading building standards and codes.
    - Retaining flexibility and adaptability in EO programming.
    - Improving EO opportunities for all customer classes.
    - Improving low-income EO programming.
    - Integrating EO with utility business models.
    - Integrating EO with an RPS into a larger clean energy standard.
    - Greater consistency across utility programs such as commonality of forms and rebates providing for reduced confusion among contractors and customers.
    - Create incentives or remove the current disincentive for peak reductions and load management in order to reduce system peak loads.

<u>Michigan's EO Potential</u>

The Michigan Public Service Commission, DTE Energy and Consumers Energy worked together to complete a study in 2013 of energy efficiency potential in the state of Michigan. This draft study assesses electric and natural gas energy efficiency potential in Michigan over ten years, from 2014 through 2023. This energy efficiency potential study provides a roadmap for policy makers and identifies the energy efficiency measures having the greatest potential savings and the measures that are the most cost effective. GDS Associates, the consulting firm retained to conduct this study, produced the following estimates of energy efficiency potential:

- Technical potential
- Economic potential
- Achievable potential

Summary of Key Findings in the Draft Potential Study

- This study examined 1440 electric energy efficiency measures and 811 natural gas measures in the residential, commercial and industrial sectors combined. The MPSC staff, utilities in Michigan, and stakeholder organizations all had input to the list of measures examined in this study.
- For the State of Michigan overall, the *economic* potential for electricity savings over the next ten years (2014 – 2023) ranges between 31% and 35% of forecast kWh sales for 2023. The *achievable* potential for electricity savings over the next ten years (2014 – 2023) is a range of 14.5% to 16.1% of forecast kWh sales for 2023.
- For the State overall, the *economic* potential for natural gas savings over the next ten years (2014-2023) ranges from 18.7% to 30.7% of forecast MMBtu sales for 2023. The *achievable* potential for natural gas savings over the next ten years (2014 – 2023) is a range of 10.5% to 14.7% of forecast MMBtu sales for 2023.

- The available energy efficiency potential may vary between individual utilities in Michigan.

<u>Energy Efficiency Options and Analysis (Optimal Energy Phase 2 Study)</u>

Building upon the Energy Efficiency Potential Study, Optimal Energy is currently conducting an analysis for Michigan to develop options for energy savings targets. The efficiency potential estimates from GDS Associates' draft potential study will be used to develop and present four concrete options for quantified annual energy and capacity targets and funding caps for years 2016-2020. In addition, the Optimal Energy Phase 2 Study will quantify options for demand targets and will explore expanded savings opportunities. The Optimal Energy Phase 2 Study is expected to be released later this fall.

<u>Summary</u>

- Michigan's utilities have met and are expected to meet near-term EO targets.
- The EO programs in Michigan to date, have been cost-effective.
- Michigan has the potential to continue to achieve incremental cost-effective savings from energy efficiency.

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A. Summary review of the process

To inform future energy choices, the Governor requested that interested Michiganders communicate information relevant to the policy making process. As Governor Snyder directed, the Michigan Public Service Commission (MPSC) and Michigan Energy Office (MEO) engaged in an information gathering process which provided for both written and oral input from legislators and the public. This process was outlined in Appendix A to Governor Snyder's Special Message on Energy and the Environment (p. 20), entitled *Readying Michigan to Make Good Energy Decisions*.[1] The process includes identifying what information needs to be compiled or developed, and arranging for that information to be generated, as needed.. As the process directs, these reports are "strictly informational and will not advocate for or recommend any particular outcome or policy." This draft report is being made available for public review and input, prior to finalization.

An Energy Efficiency page was established on the *Ensuring Michigan's Future* website.[2] The web page included 23 questions about energy efficiency policies and programs in Michigan, and invited readers to comment by April 25, 2013. By that date, 30 groups and individuals had submitted a total of 87 responses to the 23 questions. Table 1 presents a brief summary of the respondents. The process asked individuals to identify themselves, but in some cases only first names are provided and commenters did not identify their related professional affiliations, if any.

As Table 1 shows, 20 individuals or groups provided only one response each, one individual filed two responses, Michigan Electric and Gas Association (MEGA) filed three, another individual and the Nature Conservancy filed four each, and four different groups filed five each, including Consumers Energy, DTE Energy, 5 Lakes Energy, and the Michigan Energy Efficiency Contractors Council. Joint responses representing the points of view of multiple Michigan utility companies accounted for 15 responses, and the Natural Resources Defense Council submitted 16.

This report reviews the information provided through the public information-gathering process. Respondents answered questions regarding energy efficiency programs both in Michigan and in other jurisdictions. Specifically, the questions and this report examine Michigan energy providers' energy optimization (EO) programs.. Where respondents may have disagreed in important ways, this report examines differences between the assumptions and data used to reach the differing conclusions. The intent is neither to endorse nor criticize any of the mentioned programs. Instead, it is to provide factual information to support public policy decision-making.

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1 http://www.michigan.gov/energy/0,4580,7-230-63817-290530--,00.html

2 The *Ensuring Michigan's Future* website is http://www.michigan.gov/energy, and the link to the Energy Efficiency page is http://www.michigan.gov/energy/0,4580,7-230-54284---,00.html.

Table 1: List of Responses Filed

Name, Organization or Affiliation (if listed)	Number of Responses	Question Numbers
1. Art, Michigan Electric Cooperative Association	1	15
2. Beth	1	15
3. Bill	1	2
4. Brindley Byrd, Michigan Energy Efficiency Contractors Council (MEECC)	5	1, 2, 3, 10, 13
5. Chuck	1	2
6. Consumers Energy	5	3, 12, 16, 19, 22
7. Joint response from Consumers Energy, DTE Energy, and MEGA	15	1, 2, 4, 5, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 21
8. David Meeder, Michigan Energy Options	1	16
9. Douglas, 5 Lakes Energy	5	6, 9, 15, 16, 20
10. DTE Energy	5	3, 6, 16, 19, 22
11. Fred, Great Lakes Energy Member	1	17
12. Fred M, SunSpace Energy Systems, LLC	1	16
13. James	2	5, 6
14. James, Michigan Electric and Gas Association (MEGA)	3	1, 2, 3
15. Jim, Michigan Land Use Institute (MLUI)	1	10
16. JoAnn, Great Lakes Renewable Energy Association (GLREA)	1	6
17. John, Michigan Energy Options	1	16
18. Mark, Better World Builders	1	9
19. Lee, ASME (American Society of Mechanical Engineers?)	1	2
20. Martin, American Council for an Energy Efficient Economy (ACEEE)	1	7
21. Michigan Public Service Commission (MPSC) Staff	1	1
22. Naomi	4	2, 5, 10, 19
23. Peter, Dow Chemical Company	1	10
24. Sidel Systems USA, Inc.	1	1
25. Rebecca Stanfield, Natural Resources Defense Council (NRDC)	17	1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 17, 19, 21, 22
26. Rich, The Nature Conservancy	4	2, 6, 10, 19
27. Robert, Association of Businesses Advocating Tariff Equity (ABATE)	1	8
28. Ryan, Thermo Source	1	10
29. Scott	1	9
30. Thom	3	10
Total	**87**	

B. Overview of the questions and responses

Figure 1 shows how the content of the responses falls into four major categories: (1) the existing history with and evaluation of Michigan utility EO programs; (2) comparing Michigan's EO standard to efficiency standards in other states; (3) identifying and quantifying the benefits and costs from EO; and (4) alternatives for improving Michigan EO programs.

Figure 1: Responses by Major Category

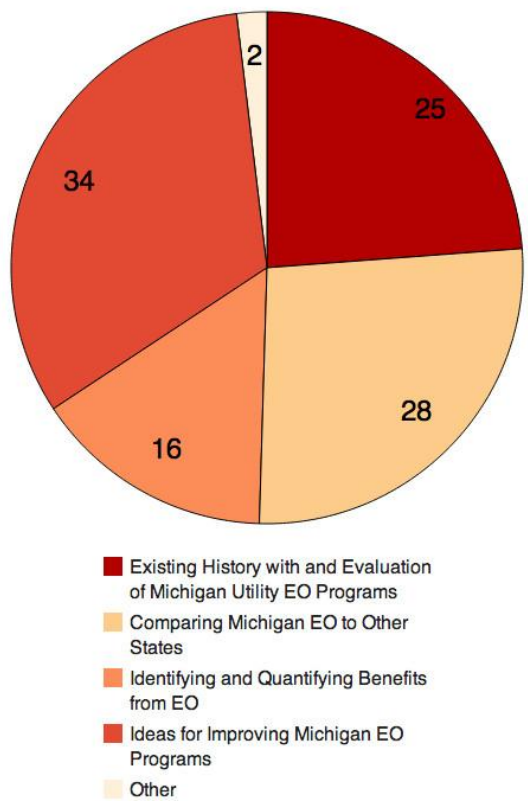

Table 2 briefly summarizes the responses submitted for each of the 23 questions and Table 3 summarizes how the responses relate to the four major content categories. Each major content category is listed in Table 3, and the data shows the total comments related to the category, followed by the breakout, question by question, showing how many of the responses to each question focused on information relevant to the content category. As this data shows, some of the responses to specific questions fall into multiple categories, including some of the responses to questions two through ten, 12, 13, 15, 16, 18, 19, 21 and 22.

Table 2: Summary of Responses Received about Energy Efficiency on *Ensuring Michigan's Future* Website

Question No.	Number of Responses	Response Complete or Partial	Lack of Consensus	Differing Data or Conflicting Information	Further Information Needed	Links to other questions
1	6	Complete				2, 3, 4, 7, 9, 10, 12
2	9	Complete			Yes	1, 3, 4, 6, 7, 10, 11, 13, 14, 16, 18, 19, 22, 23
3	5	Complete	Yes			1, 2, 4, 5, 6, 7, 10, 11, 14
4	2	Complete				2, 3, 5, 7, 12, 14, 15, 16, 18, 19, 22, 23
5	4	Partial				2, 3, 4, 7, 10, 11, 12, 13, 14, 15, 16, 19, 21, 23
6	8	Partial				7, 8, 9, 11, 12, 14, 15, 16, 18, 19, 20, 22.
7	3	Complete	Yes			3, 4, 5, 6, 10, 13, 14, 15, 16, 18, 19, 22
8	3	Complete				18, 20
9	4	Partial				11, 15, 16, 17
10	12	Partial		Yes	Yes	2, 3, 4, 6, 7,13, 14, 15, 16, 18, 19, 22
11	2	Complete				2, 6, 9, 14, 16, 22, 23
12	2	Partial				2, 7, 14, 16, 23
13	3	Complete	Yes			2, 3, 7, 11, 14, 16, 17, 22, 23
14	2	Complete				2, 4, 5, 6, 7, 10, 11, 12, 13, 16, 23
15	4	Partial				4, 5, 6, 7, 9, 10, 17, 19, 22
16	6	Partial				2, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
17	3	Partial			Yes	2, 3, 4, 6, 9, 13, 15, 19
18	1	Partial				2, 4, 6, 7, 8, 10
19	5	Partial	Yes		Yes	2, 4, 5, 6, 7, 10, 15, 17
20	1	Partial			Yes	6, 8
21	2	Partial				5, 15, 22
22	3	Partial				11, 13, 15, 21
23	2	Partial				12, 13, 14, 15

Table 3: Relating Responses to Major Categories of Comments

Question Number	History of Michigan EO Implementation	Comparing Michigan EO to Other States	Identifying, Quantifying Benefits and Costs of EO	Improving Michigan EO Programming	Other Topics
1	5				
2	2		4	3	
3	5			4	
4	2			1	
5			4	2	
6		3	3	2	2
7		2	2	1	
8	2	2		1	
9		1		3	
10	1	1		4	
11		2			
12	1	2	2		
13		3		2	
14		2			
15	1	1		1	
16	2	1		3	
17				3	
18	1			1	
19	1	3		1	
20		1			
21		2		1	
22	1	2	1	1	
23	1				
Total	**25**	**28**	**16**	**34**	**2**

II. Existing History with and Evaluation of Michigan Utility EO Programs

A. Introduction

Michigan's energy efficiency standards are articulated in Michigan's *Clean, Renewable, and Efficient Energy Act* (Public Act 295 of 2008, MCL460.1077).[3] The law indicates that cost-effectively implementing the standard is intended to:

(a) Diversify the resources used to reliability meet the energy needs of consumers in this state.
(b) Provide greater energy security through the use of indigenous energy resources available within the state.
(c) Encourage private investment in renewable energy and energy efficiency.
(d) Provide improved air quality and other benefits to energy consumers and citizens of this state.[4]

Energy savings targets increase annually in the early years, with goals for efficiency savings identified separately for electric and natural gas utility EO programming.

Electric utilities are required to achieve savings equal to:

- 0.3% of 2007 sales in 2009;
- 0.5% of 2009 sales in 2010;
- 0.75% of 2010 sales in 2011; and,
- 1.0% of previous-year sales each year from 2012 to 2015.

Natural gas utilities have targets of:

- 0.1% of 2007 sales in 2009;
- 0.25% of 2009 sales in 2010;
- 0.5% of 2010 sales in 2011; and,
- 0.75% of previous-year sales from 2012 to 2015.

The law took effect in fall 2008. By mid 2009 the Michigan Public Service Commission had already issued the first orders intended to implement the energy efficiency provisions of the Act.[5] Among other decisions, those early orders established a Michigan Energy Efficiency Collaborative, to provide opportunities for "electric and gas providers…, energy efficiency experts, equipment installers, and other interested stakeholders… to participate." The initial goals of the Collaborative included:

- Making recommendations for improving energy optimization programs for all providers;

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3 http://legislature.mi.gov/doc.aspx?mcl-460-1077

4 http://legislature.mi.gov/doc.aspx?mcl-460-1001

5 For additional details, see http://michigan.gov/mpsc/0,1607,7-159-52495_53750-217178--,00.html

- Providing program evaluation support and developing any needed re-design and improvements to energy efficiency programs;
- Updating and refining the Michigan Energy Measures Database, on the basis of actual experience; and
- Promoting economic development and job creation in Michigan by providing a forum to connect Michigan manufacturers, suppliers and vendors with utility EO programs.

To date, four work groups have been established under the auspices of the Collaborative, including: (1) Economic Development Forum; (2) Evaluation Workgroup; (3) Low-Income Programs; and (4) Program Design and Implementation.[6] The work groups began meeting in fall 2009 and meetings are continuing.

In addition to the request for information in response to the 23 questions posed on the *Ensuring Michigan's Future* Energy Efficiency web page, Michigan has been in the process of obtaining current information about energy efficiency benefits, cost-effectiveness, and projections of the opportunities for continuing utility EO programming, through a series of contracts. The following three reports, attached to this document as Appendixes B, C, and D, have also been submitted to support this policy information-gathering and review process:

Appendix B: ***Michigan Electric and Natural Gas Energy Efficiency Potential Study***, prepared for Michigan Public Service Commission by GDS Associates (2013), summarizes the benefits of and explores the benefits and costs of continuing utility EO programming in Michigan. Benefits analyzed include "avoided cost savings, non-electric benefits such as water and fossil fuel savings, environmental benefits, economic stimulus, job creation, risk reduction, and energy security" (GDS, 2013a, p. 14). GDS concludes, "[T]here remains significant achievable cost effective potential for electric and natural gas energy efficiency and demand response measures and programs in Michigan." (GDS, 2013a, p. 16). The Potential Study is discussed further in Section IV (C) of this report.

Appendix C: ***Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges*****,** report to the Michigan Public Service Commission by Optimal Energy (2013), reviews and assesses how EO program goals and administration can be revised and managed to best promote cost-effective, long-term energy savings, as opposed to focusing more narrowly on short-term, low cost measures. The objective of the Optimal Energy report (2013, p. 4) is to "describe a set of policy options for the Public Service Commission and other Michigan stakeholders to consider in order to reduce the bias to pursue savings that may be the most inexpensive from a first-year perspective, but not necessarily optimal in the longer-term."

6 The Energy Efficiency Collaborative web page, at http://michigan.gov/mpsc/0,4639,7-159-52495_53750---,00.html, includes links to web pages for each of the four work groups, which provide more detailed information about each of the four work groups.

Appendix D: ***Energy Efficiency Cost-Effectiveness Tests***, by Synapse Energy Economics, Inc. (Malone *et al*., 2013), reviews and summarizes the standard benefit-cost tests used to evaluate energy efficiency measures and programs. That report "addresses current issues with cost-effectiveness screening practices. It summarizes and compares the current energy efficiency cost-effectiveness policies and practices in Michigan and other jurisdictions." It reviews Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin and compares Michigan's policies and practices to those jurisdictions (Malone *et al*., 2013, pp. 1, 2). Portions of the Synapse report are incorporated throughout this document.

B. Summary of Michigan EO program evaluations to date

Multiple respondents referenced the Michigan Public Service Commission's 2012 Report on the Implementation of PA 295 Utility Energy Optimization Programs. Responses to this question show that Michigan's electricity and gas utilities are, on average, surpassing the standards set forth in PA 295. Natural gas utilities achieved 134% of their targets in 2011, while electric utilities achieved 116% of theirs. While results vary from utility to utility, evaluation data shows that Michigan's energy savings targets were met through 2011. A general conclusion reached by the evaluators thus far is that for each dollar spent on the utility EO programs to date, customers will benefit from $3 in avoided energy costs, reaching an estimated total of $1.2 billion as a result of program operations in 2013 through 2015.

Although reports for 2012 savings are not final, Commission Staff endorses the Energy Optimization program as successful (MPSC Staff, 2013). In 2011, the combined average energy savings for providers met 125% of the targets created in PA 295. That report shows how electric utilities have surpassed Michigan's EO standards each year since implementation and gas utilities have also exceeded legislative targets.

Commenters agree that the EO programs to date have been cost effective. NRDC's response to question 3 includes summaries of first year and life-cycle program costs and savings for both gas and electric energy optimization programs for Consumers Energy and DTE Energy. NRDC also includes estimated cost of conserved energy prices for Consumers Energy (2 cents per kWh for electricity, and $1.76 per MCF of natural gas) and DTE Energy (1 cent per kWh for its electric portfolio, and $1.5 per MCF for its gas programs).

Responses to question 4 from Michigan utilities and NRDC both provide details about the cost of conserved energy associated with the existing EO programs. Both comments refer to the MPSC evaluation reports (most recently MPSC, 2012), and the NRDC report also refers to a Consumers Energy (2012) report. NRDC relays average 2011 electricity generation costs and natural gas commodity costs as reported by the U.S. Energy Information Administration. Based on those data, NRDC concludes that Michigan's EO programs are cost-effective.

The responses agree about the present cost of conserved energy estimates, but neither addresses the history by class or the history of savings for participants and non-participants, as question 4 asks. The short-term history from 2008 to the present is readily accessible in the annual evaluation reports. There is also useful information for addressing this question in responses to questions about benefit-cost testing.

C. Michigan energy optimization programming by customer class [7]

The utilities' joint response to question 8 discusses Michigan's classes extensively, and introduces the concept of the customer option for adopting a self-directed EO plan (MPSC, 2010b). Both the utilities and NRDC discuss some of the specific provisions of Michigan's *Clean, Renewable, and Efficient Energy Act* (2008 PA 295; MCL460.1001 et seq.). NRDC refers to section 71(3)(d), which establishes that charges collected from a customer class must be spent within that same rate class (MCL460.1071).

For the purposes of EO programming, Michigan can be understood as having five customer classes: residential, commercial, industrial, low-income, and self-directed. PA 295, Section 89 provides for low-income class funding through proportional collections from the other four customer classes (MCL460.1089).

Michigan's self-directed class consists of non-residential customers who meet minimum peak demand usage requirements and choose to operate their own energy efficiency programs. These customers must achieve the same energy savings targets established by PA 295. NRDC explains that the MPSC Order in Case No. U-15800 establishes temporary guidelines for self-directed EO plans. Self-directed customers are still obligated to contribute to the low-income class fund, but do not pay the full EO surcharge (MPSC, 2010b).

Question 18 asks specifically about how Michigan and other jurisdictions have coordinated low-income weatherization programs. One response to that question was provided on the Ensuring Michigan's Future website, as a joint utility response from Consumers Energy, DTE Energy, and MEGA. The utilities explain, in Michigan a number of low-income programs are assigned to different state agencies and additional support comes from utility-sponsored and ratepayer funded charitable contributions and through non-governmental organizations. The majority of Michigan's weatherization funding comes from the Low Income Home Energy Assistance Program (LIHEAP) and the Weatherization Assistance Program (WAP). LIHEAP is run by the U.S. Department of Health and Human Services and administered by Michigan's Treasury and Department of Human Services. WAP is funded by the U.S. Department of Energy and administered by Michigan's Department of Human Services.

D. The role of EO in utility planning

The GDS report (2013a, p. 14) reports "states are turning to energy efficiency as the most reliable, cost-effective, and quickest resource to deploy."

NRDC approaches this issue by examining Michigan's resource planning process. Noting that Michigan's EO plan was adopted to delay construction of new generating capacity, NRDC

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[7] This issue is also discussed in Part III.C. of this report, comparing Michigan to other states.

embraces integrated resource planning proceedings which examine a number of methods, including energy efficiency, to meet new demand. Michigan law (MCL 460.6s)[8] requires a long-range resource plan for generation projects that cost more than $500 million, but NRDC states that few utility facility projects will meet this spending threshold. NRDC recommends that each Michigan utility should undertake integrated resource planning on a regular basis, that the planning process incorporate energy efficiency and renewable energy, and that a certificate of necessity be required for smaller projects. A change in legislation would be needed to require such certificates for smaller projects, though. It should be noted that a change in legislation may be needed to *require* such certificates for larger projects as well.[9]

The utility's joint response to question 10 reviews the logical sequence by which EO measures and programs are explored, analyzing technical, economic, achievable, and program potentials. The GDS study (2013a, p. 32) also explains the systematic approach to modeling and incorporating EO into utility planning. Chapter 5 of the GDS report (pp. 32-45) reviews in detail the process typically used for evaluating EO potential, and GDS Figure 5-1 (p. 35) depicts the process for determining "achievable potential."

The joint utility response also cautions, however, that:

> Future savings… are likely to be somewhat more expensive to achieve than in the past. … A current and rigorous energy efficiency potential study for the state of Michigan that factors in the latest changes in baselines, Michigan Energy Measures Database deemed savings values, and codes and standards, as well as other criteria identified by interested stakeholders, would best serve to inform the planning process.

Figure 5-3 from the GDS report (2013a, p. 41) further illustrates this point, by differentiating between lower-cost measures with higher savings opportunities, mid-range measures in terms of both costs and savings, and higher-cost measures with smaller savings. One of the utilities' concerns is that lower-cost measures with higher-savings will be obtained first, leaving more expensive measures with lower savings for later years.

The utilities joint response to question 21 points to seven states, including Michigan, that provide some mechanisms whereby energy efficiency savings can qualify as an eligible resource towards meeting renewable portfolio standards (RPS) goals. Each of these states places a cap on the maximum contribution of efficiency savings to the RPS target. Michigan's limit, at 10% of the RPS target, is the lowest, in terms of percentage (NREL, 2012). The utilities support allowing energy efficiency as an RPS resource, noting an NREL study that compares the cost of renewables and energy efficiency. NREL's study shows that the price of energy efficiency programs is significantly cheaper than that of renewables. The joint response supplements this conclusion with two Michigan PSC reports (MPSC 2012a, MPSC 2012b):

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8 This provision was added by 2008 PA 286 (http://legislature.mi.gov/doc.aspx?mcl-460-6s).

9 See Section 6s(1) of PA 286 of 2008: (http://www.legislature.mi.gov/%28S%28jvxszg552nqqls55um2dbt55%29%29/documents/2007-2008/publicact/pdf/2008-PA-0286.pdf).

> In Michigan, the Michigan Public Service Commission report found that <u>the weighted average energy optimization cost of conserved energy was $20 / MWh, compared to a life cycle cost of $91.19 / MWh for renewable energy</u> [emphasis included in original].

Additionally, the joint response offers that including energy efficiency in an RPS can enhance compliance flexibility and broaden political support. The utilities note that future federal portfolio standards policies are uncertain, and that some federal legislative proposals would allow energy efficiency savings to count towards meeting renewable standards.

In its response to question 22, Consumers Energy states that "flexibility, creativity, and innovation" are all required in the design and operation of energy optimization programs, "to capitalize on emerging opportunities or make rapid mid-course changes, without the delay of regulatory review." Consumers Energy states:

> A regulatory framework that provides utilities a multi-year savings target, the ability to bank savings from one year to the next, large degree of flexibility, and the ability to carry-over unspent dollars into subsequent years, provides more flexibility to achieve overall savings targets.

DTE Energy says that Michigan's current law does not have a mechanism "to reduce the savings target when energy optimization plans indicate that the costs to customers would exceed a maximum set by the PA 295." But, DTE notes that Michigan's law does provide "some administrative flexibility in the standard to help adapt to unforeseen circumstances." DTE Energy explains:

> Michigan law does allow utilities to spend more than the spending caps with approval from Michigan Public Service Commission, but there is no mechanism to exceed the customer class [cost] recovery caps.

DTE Energy, like Consumers Energy, supports the idea of "standards that have a high degree of flexibility to deal with unforeseen circumstances and prevent unintended consequences."

DTE Energy further describes provisions of PA 295 and Commission decisions that result in flexibility in EO program design and implementation. DTE Energy lists:

- Energy savings in one year can be rolled forward to the next year, fulfilling up to one third of the subsequent year's goals, but the utility must forgo its financial incentive if it chooses to do so
- A utility or a provider can submit a plan that exceeds the 2% cost cap and receive commission approval if the plan is prudent
- The commission can adjust small utility savings goals and approaches
- The commission can end a program that does not meet the basic cost effectiveness requirements
- A utility can redirect up to 30% of program funds to programs that need additional funding (U-15806 and U-15890)

- A utility can develop new programs and launch them through “emerging programs” process (U-17049 and U-17050)
- A utility can roll forward unspent funds from one year to the next as long as the overall plan is under the spending cap (U-17049 and U-17050)

DTE Energy’s conclusion is that Michigan’s current system allows a good deal of flexibility, but “a fundamental issue that could arise over time… is that the <u>cost</u> of energy efficiency programs needs to realistically align with the state’s energy efficiency <u>goals</u>” [emphasis in original].

NRDC notes the value of energy efficiency, itself, as a tool that affords utilities and customers with greater flexibility and the ability to “adapt to unforeseen circumstances.”

In its response to question 23, MiEIBC notes that Michigan evaluates energy efficiency investments for first year savings to determine compliance with the Energy Optimization Standard, and evaluates investments over the useful life of the measure when considering cost-effectiveness and for reporting the net benefits of the programs. As MiEIBC indicates, the useful life of measures is one of the data elements included in the *MI energy measures database* (MPSC, 2013).

MiEIBC also notes that current accounting practices treat energy efficiency expenditures as recoverable in the first year, rather than stretching them out over multiple years, reflecting the useful lives of the measures. As MiEIBC points out, if the alternative, longer-term cost recovery were applied, it would have the effect of “relaxing the program spending cap, which would enable implementation of more costly but longer-lasting energy efficiency measures.”

III. Comparing EO in Michigan to Other States

A. Overview

Sixteen of the 23 questions about energy efficiency ask explicitly for information about policies and experience in other jurisdictions. About one-quarter of all the comments are focused on other states and how Michigan's EO programming and policies compare to other states.

In its response to question 6, the Nature Conservancy references four recent reports from ACEEE, which include comparisons of state standards (Foster, 2012; Sciortino, 2011; Nowak, 2011; and York, 2012). Consumers Energy provides a summary table showing (1) electric and natural gas efficiency standards for over a dozen states and (2) state average electricity costs (in ¢/kWh), drawn from U.S. EIA data. DTE Energy notes that 20 states have adopted energy efficiency resource standards (EERS), which variously apply to electricity, natural gas, or both.

A joint response from the utilities elaborates on the general nature of and objectives intended for energy efficiency programs:

> The standards are met by the utility expending funds on programs designed to encourage customers to make their homes or businesses more energy efficient. The programs typically include rebates or incentives to reduce the upfront cost of energy efficiency upgrades such as furnaces, lighting, motors, and insulation, as well as marketing and outreach to make customers aware and motivated to act. The overarching policy objectives of these programs include, but may not be limited to, delaying the need for electricity generation, reducing pollution, encouraging local job creation, and lowering customer's utility bills.

DTE provides a map showing the states and an Appendix outlining "EERS Policy Details." DTE explains that the state standards "generally allow a broad range of end-use efficiency programs to count," but also points out that the states differ on whether to include combined-heat-and-power, applications of waste-heat, reduced transmission and distribution system line losses, and electric generator efficiency upgrades. Michigan's standard does not explicitly include those categories, but DTE points out that "other states (e.g., Arizona, Rhode Island, Florida, Massachusetts, Maryland, New York) include one or more." Utility comments in response to question 7 provide the following information about other state energy efficiency standards:

- Six states have standards that are 2.0% of electric sales or higher and nine (including Michigan) have standards between 1.0% and 1.9%.
- Five of nine states have natural gas standards above 1.0% and three of nine (including Michigan) have standards between 0.5% and 0.9%.

The Joint Response supports flexible standards:

> Costs and benefits of achieving different standards can vary among utilities based on their size, type, service area, capacity needs, and other factors. Therefore,

> statutory standards should build in flexibility with common sense oversight by the Michigan Public Service Commission (MPSC).

None of the responses to question 6 explicitly identify any correlation between a state's energy efficiency standard and the state's cost of energy or excess generating capacity. Consumers Energy contends data and studies do not demonstrate a correlation; DTE remarks that it could not identify any study that discusses such correlations.

In a joint response to question 7, the utilities report that many states have energy efficiency standards with policy objectives that "include, but may not be limited to, delaying the need for electricity generation, reducing pollution, assisting low-income households, encouraging local job creation, and lowering customer's utility bills." Illinois and Massachusetts, for example, have specific low-income goals. The utilities state that energy efficiency programs are paid for through a customer surcharge, and explain:

> Customers can realize a reduction in their monthly bill (in excess of the surcharge) if they use energy efficiency measures covered by the utility's programs. Customers who do not participate would see an increase in their rates in the near term but could benefit over the long term through the utility avoiding certain costs, such as fuel or deferred capital investments.

The utilities point out that the Michigan standard has dual features: One is the annual targets for electricity and natural gas savings; the other is a spending cap, not to exceed 2% of each utility's annual revenues. This cap is discussed in question 13.The utilities note that some other states have standards higher than Michigan's, but they question whether the higher standards will prove to be "consistently achievable." They also caution that:

> [C]omparing the standards across states can be challenging because of the nuances in the way the standards are defined and how savings are credited. The standards also build in assumptions about load growth, economic activity, weather, demographics, and other factors and, therefore, caution should be used when comparing the percentage targets.

Detroit Edison notes that cost caps exist in Illinois, Michigan, Pennsylvania, and Wisconsin, and "off ramps" for EERS exist in Ohio, New Mexico, and Oregon. For example, Pennsylvania has a spending cap of 2% of utility revenues and Wisconsin has a 1.2% revenue cap. At least one state, Illinois, has cap on rate increases. Instead of explicit caps, several states restrict expenditures to cost-effective energy efficiency.

B. Applying the standard benefit-cost tests

The Synapse report summarizes how state public utility commissions have used benefit-cost tests for energy efficiency:

> Since the inception of ratepayer-funded energy efficiency programs, cost-effectiveness screening practices have been employed to ensure that the use of

> ratepayer funds results in sufficient benefits. Screening practices have allowed regulators to promote investments in energy efficiency resources that benefit customers, utility systems, and society. In general, historical energy efficiency programs have proven successful with strong cost-effective results, leading to additional investment in energy efficiency resources.

The utilities' joint response to question 14 explains that PA 295 requires that EO program cost-effectiveness be evaluated using the Utility System Resource Cost Test (USRCT) ([MCL460.1073(2)](MCL460.1073(2))). The Joint Response comments that:

> Although there are other methods to score cost effectiveness including the Total Resource Cost (TRC), Participant Cost Test (PCT), Rate Impact Measure (RIM), and Societal Cost Test (SCT), the USRCT is most practical and straightforward to implement.

The USRCT focuses on costs that a utility would incur during a program and the avoided-cost benefits that would result. This is one of five tests used by various jurisdictions. The Joint Response defines each of these tests. The RIM test, for example, measures price changes caused by changes in utility revenues and operating costs associated with a program. The PCT is specific to demand-side management programs, and compares bill savings with the cost of equipment upgrades. This calculation determines how attractive a demand-side program would be to consumers. Finally, the SCT is a variation of the TRC that expands the focus to society as a whole, including environmental and non-energy benefits.

Synapse notes that different tests provide different types of information. Each test is designed to estimate the costs and benefits of efficiency investments from different perspectives. For example, Synapse notes that the SCT includes societal impacts that may include environmental impacts, reduced health care costs, economic development impacts, reduced tax burdens and national security impacts. Synapse reports that the TRC includes all the costs and benefits to the program administrator and the program participants offering the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the participating customer. The USRCT, referred to as the Program Administrator Cost (PAC) test by Synapse, includes all of the costs and benefits incurred by the utility to implement efficiency programs, and all the benefits associated with avoided generation, transmission and distribution costs. Synapse notes that this test is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs. This test provides an indication of the extent to which utility costs, and therefore average customer bills, will be reduced by energy efficiency.

In sum, each of the five tests examines different costs and benefits. The Joint Response provides an illustration of components measured by each test. As examples, the total resource cost (TRC) test includes as benefits (1) avoided supply costs, other resource savings (e.g., water) and other non-energy benefits, and as costs (2) program administration, program financial incentives and customer contributions; the utility cost test (UCT or USRCT) excludes customer contribution as a cost; and the participant cost test includes bill savings and other resource savings as benefits and only customer contributions as cost.

NRDC provides a similar matrix, which, despite some categorical differences, presents a similar analysis of the five tests. Both the Synapse report and the utilities' joint response to question 14 contain a detailed discussion of each test.

Twenty-nine states use the TRC test, making it the most commonly used cost effectiveness test. Six jurisdictions use SCT, five including Michigan use the USRCT, one uses RIM, and five have no specified primary test (Schiller, 2013). No states use PCT as their primary test, but a number of states supplement their tests with a PCT (Kushler, 2012).

The utilities' joint response sums up its support for the USRCT:

> There is no national consensus on which test is the best for measuring energy efficiency programs. While many utilities use the TRC test, the elements that are measured in the TRC vary widely. However, every state uses some measure of "utility system avoided costs" as a benefit, and every state treats "energy efficiency program costs" as a cost. The USRCT has the advantage of being simpler and much less expensive to calculate, given that the inputs are data that the utility generally already has. The USRCT also incorporates energy efficiency as a supply side investment similar to how other utility decisions are made.

NRDC illustrates why it is difficult to determine the best test by listing a number of under-represented benefits.[10] NRDC notes the difficulty in accounting for each benefit, but insists that cost-benefit tests should attempt to maintain awareness of all benefits. Overall, NRDC finds shortcomings in the USRCT by viewing cost-effectiveness from the perspective of only the utility; thus, it omits placing a value on environmental improvement and the added comfort to customers, and any macro-economic benefits or any societal benefits created by the programs. NRDC identified a January 2013 presentation that includes a slide showing which test is used in each state, and the key features.[11]

Synapse reports that ever since ratepayer-funded energy efficiency programs have been in place, there has been considerable debate about which test is best to use for screening energy efficiency. However, it should be noted that – while the choice of test is important – it is even more important to ensure that each test is properly applied. Sound screening practices should (a) generally meet the state's energy policy goals, (b) use a screening test that is consistent with the state's energy policy goals, (c) apply the chosen screening test in a way that is internally

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[10] These benefits include: Utility benefits – reduced arrearages and carrying costs, demand reduction induced price effect, reduced risk; Customer/Participant benefits – increased property value, aesthetics, building durability, comfort, health benefits for participants and society; and Societal benefits – job creation, economic growth from lowering energy costs, environmental benefits.

[11] *See* http://www.meeaconference.org/uploads/file/ppt2013/MES_2013_Thu-01-17/MES_2013_Thu-01-17_Schiller.pdf.

consistent, (d) use methodologies that are consistent with the perspective of the chosen test, and (e) account for all the costs and benefits that are relevant to the chosen test.

The Joint Response details Michigan's compliance procedures, which includes annual reporting of efficiency program cost-effectiveness using a USRCT. No comparisons to lifecycle or annual saving calculations in other jurisdictions were made by either of the commenters. State to state comparisons of energy efficiency programs is not straightforward as many differences exist between individual jurisdictions.

The Synapse report, included as Appendix D, includes a summary of the cost-effectiveness screening practices in eight states in addition to Michigan. The eight states are Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin. For each state, Synapse researched three primary attributes regarding cost effectiveness screening: cost-effectiveness test(s) and their application, the avoided costs included in the primary cost-effectiveness test, and the other program impacts included in the primary cost-effectiveness test.

Synapse reports the following results of the eight states surveyed:

1. All of the states we surveyed provide relatively comprehensive energy efficiency programs according to ACEEE, as they are all ranked within the top 20 most energy efficient states.
2. Cost-effectiveness practices are largely driven by key policy objectives specific to each state.
3. Most states screen for cost-effectiveness using the TRC as the primary test, while a few states rely on the Societal Cost test or the PAC test as the primary test.
4. Most states determine cost-effectiveness at either the portfolio or program level, with one state screening at the measure level and one state screening at the sector level. Most states consider results from additional screening levels in addition to the primary screening level.
5. Several different discount rates are used across the states, although the utility weighted average cost of capital is most frequently used by the states. Other states use low-risk or societal discount rates. We note that different discount rates can have significant impacts on the results of the cost-effectiveness screening.
6. All but one state apply a study period that includes the full useful life of the measures.
7. All states account for avoided costs of energy, capacity, and complying with environmental regulations. However, we did not investigate the extent to which the methodologies, assumptions and results are appropriate or consistent across the states.
8. All but one state account for avoided costs and transmission and distribution.
9. Most states do not account for price suppression effects, with only two states including such benefits.

10. Most states do not account for risk mitigation benefits, with only two states include such benefits.
11. All but one state that uses the TRC test or the Societal Cost test account for the participant-perspective resource benefits: water savings, oil savings, gas savings (for electric utilities), and electric savings (for gas utilities).
12. All but one state at least qualitatively account for the participant-perspective low-income benefits, typically by not requiring that low-income programs or measures pass the state's cost-effectiveness test.
13. States treat the participant-perspective non-energy benefits very differently:
    - One state uses quantified values for non-energy benefits.
    - Two states use adders to represent non-energy benefits.
    - Several states include few or no non-energy benefits, despite using the TRC test or Societal Cost test as the primary test.

C. Implementing energy efficiency programming by customer class

The utilities examine how a number of other jurisdictions, including Iowa (ACEEE, 2013) and California (California Public Utilities Commission, 2012), apply energy efficiency standards to various customer classes. According to the utilities' Joint Response, some states, such as Massachusetts and Illinois, include specific savings or spending targets for the low-income class.

The Joint Response compares sector-specific goals in various jurisdictions. The utilities note that a number of states, including Michigan, have no savings targets for any specific class. California has different class categories (residential, commercial, industrial, and agricultural); it does not allocate any goals for those specific sectors, however. The same is true in Iowa, Wisconsin, and Connecticut.

The utilities' joint response to question 8 explains that Michigan's self-directed class consists of non-residential customers who meet a minimum peak demand usage and choose to operate their own energy efficiency programs. These customers must meet the same minimum energy savings percentage targets established by PA 295.

NRDC explains that the MPSC Order in Case No. U-15800 establishes temporary guidelines for self-directed EO plans. Self-directed customers are still obligated to contribute to the low-income class fund, but do not pay the full EO surcharge (MPSC, 2010b). NRDC further reports that Wisconsin, Vermont, Minnesota, Massachusetts, and Ohio also offer the option of self-directed plan compliance, but some other states, such as Iowa, do not.

The utilities' joint response to question 18 lists 10 jurisdictions in which only one state agency controls the state's low-income program. The response notes, however, that consolidation is not necessary. Operational differences between these programs make different agencies better suited to implement different programs. The Joint Response does provide a small caveat to this recommendation, noting the need for coordination between agencies.

Additionally, many states implement programs through community action agencies (CAAs):

> Thirty states reported that CAAs were their primary local administrator for LIHEAP heating, cooling, and crisis funding, and the majority of states (including Michigan) report that CAAs are the primary customer intake site for weatherization assistance (U.S. Department of Health and Human Services, 2013).

MiEIBC, in its response to question 20, contends that:

> Michigan has followed a practice which is nearly universal among states with active utility energy efficiency programs, which is to place the obligation for providing energy efficiency programs on the distribution utilities. This is the prevalent model, regardless of whether states have "restructured" to allow customer choice or not.

MiEIBC remarks that no state has imposed an energy efficiency requirement on independent energy suppliers. Reasons include their unregulated status and the high turnover in that sector. Instead, energy efficiency programs are funded through the distribution utility, which remains under the purview of the Public Service Commission. Michigan's EO programs place the responsibility for energy efficiency on those regulated distribution utilities.

MiEIBC notes that energy efficiency programs in restructured states should be "non-by-passable," meaning that customers pay to support energy efficiency programs regardless of where they purchase generation. Since customers pay for energy efficiency and are eligible for energy efficiency programs through their distribution rates, Michigan's EO standards are met outside of the retail choice electricity market.

D. Energy efficiency in utility planning

The utilities' joint response to question 10 includes reviews how EO measures and programs are explored in a logical sequence, analyzing technical, economic, achievable, and program potentials. Without citing the source for this data, Consumers provides a table which shows a dozen states, including Michigan, that utilize multi-year planning for energy efficiency programs.

NRDC, in response to question 11, explains that Michigan's annual numerical standard is similar to those implemented in Illinois, Indiana, Ohio, Iowa, Wisconsin, Minnesota, Massachusetts, Oregon, and other states. The utilities' joint response echoes this finding, noting that:

> Numerical standards that explicitly define energy savings targets based on a percentage of retail sales is common practice across the United States. Like Michigan, many states base their savings targets, and associated performance incentives, on cumulative annual savings over a three-year period.

The Joint Response examines some of the same states as NRDC,[12] but also details programs in California (DSIRE, 2013) and Ohio. While the Joint Response illustrates some differences in the enforcement mechanisms, goal-setting processes, and commission responsibilities, each jurisdiction focuses on numerical requirements. The utilities cite a report from ACEEE (2013) as a source for this information.

The timeline for compliance varies in different jurisdictions. New York, for example, has a cumulative goal of 15% load reduction by 2015, but NRDC states that different states' overall targets are often divided into short-term increments. NRDC concludes that a multi-year approach, in practice, is similar to an annual target.

NRDC describes an "all cost-effective" requirement adopted by some states. Found in California, Connecticut, Massachusetts, Rhode Island, Vermont, and Washington, these policies dictate that utilities must capture all cost-effective energy efficiency (Barbose, 2013). However, according to ACEEE's Scorecard (Foster, 2012), each of these states also has either an annual or cumulative numerical energy efficiency resource standard (EERS).

In a response to question 12, Consumers Energy reports that nearly all jurisdictions base energy savings targets on first-year savings. Consumers Energy found just one jurisdiction that expresses savings targets in terms of lifetime savings. According to Consumers Energy, the Public Service Commission of Wisconsin, in Docket 5-GF-191, shifted its focus to lifecycle goals. In that docket, the Wisconsin PSC (in 13 Jan 2012 Order in Case No. 5-GF-191) states:

> The Commission also determined contract goals should be life cycle goals in order to reflect the true value of the savings. Therefore, it is appropriate for [the

12 Both the Joint Response and NRDC provide an assessment of Wisconsin, Illinois, Iowa, and Minnesota.

> Statewide Energy Efficiency and Renewable Administration] and the Program Administrator to negotiate gross life cycle four-year contract goals based on the net annual four-year goals adopted by the Commission.

Detroit Edison also refers to multi-year plans, using Iowa as an example.

E. Combining mandates, goals, and incentives

According to responses to question 9 from the Michigan Energy Innovation Business Council (MiEIBC) and the utilities' joint response, Michigan uses both incentives and mandates. Michigan uses a combination of mandates and incentives to encourage utility-initiated energy efficiency. The state mandates savings targets starting in 2009, with annual increases leading to the current level of 1.0% of total annual retail electricity sales and 0.75% of natural gas retail gas sales. Utilities can also earn a performance incentive for exceeding their mandated energy-savings targets. Under PA 295, Section 75 (MCL460.1075), Michigan offers as a financial incentive the lesser of:

> (a) 25% of the net cost reductions experienced by the provider's customers as a result of the implementation of the energy optimization plan or
> (b) 15% of the provider's actual energy efficiency program expenditures for the year.

Nineteen of the twenty-four states with an Energy Efficiency Resource Standard (EERS) supplement their mandates with incentives (Foster, 2012). MiEIBC notes that the six highest ranked states in ACEEE's 2012 *Scorecard* offer incentives in addition to their mandate. MiEIBC asserts, "[P]roviding some type of incentive to utilities for energy efficiency accomplishments helps encourage them to perform well in delivering customer energy efficiency programs."

Five states offer incentives, but no mandate (Foster, 2012). MiEIBC is more critical of this approach, stating:

> That approach of 'incentives available but no mandate' does not appear to be very successful, as none of those five states are in the top 30 in terms of the percent of their annual kWh sales that are saved by energy efficiency programs.

According to MiEIBC, Colorado, in contrast, offers incentives once a utility reaches 80% of its goal. MiEIBC identifies the *DSIRE Database*[13] as an extensive source of data about each state's energy efficiency programs.

[13] That is the *Database of State Incentives for Renewables & Efficiency*, a publicly available web site that strives to maintain an up-to-date index of all U.S. federal and state policies and financial incentives. See www.dsireusa.org.

MiEIBC goes on to describe the reasoning behind incentives:

> It should also be considered that our prevailing utility business model actually punishes a utility for achieving energy efficiency goals because they are selling less of the commodity from which they earn money (kWhs or Btus). As a result, many states have adopted one of two mechanisms for providing a utility with cost recovery for their investments (1) decoupling or (2) energy efficiency incentive payments.

Decoupling involves eliminating the link between a utility's revenues and sales, and Michigan's treatment of decoupling is examined in question 17 and further discussed in Part V.F. of this report. MiEIBC recommends revisiting PA 295 to expand development of a decoupling program.

MiEIBC also recommends looking outside of mandates and incentives to promote energy efficiency. MiEIBC suggests this approach can involve "market transformation" policies that focus on institutional arrangements or transaction rules, such as Energy Star labeling or rebates, and special energy efficiency financing programs like *Michigan Saves*^SM.

The utilities' joint response mentions that a common approach used in other jurisdictions is to establish energy savings targets through regulatory or legislative mandates. It adds that in several instances mandates allow for performance incentives when a utility exceeds energy savings targets. The utilities explain that performance incentives help to overcome the "inherent negative financial disincentive utilities otherwise face by reducing energy sales through their energy efficiency programs."

NRDC also explains that states typically set EERS program targets based on first-year energy savings. It notes, however, that in a refinement to annual program targets, Michigan has adopted measures to account for lifetime energy savings. NRDC points to MPSC Cases Nos. U-17049 and U-17138, where the MPSC approved incentives that encourage programs with longer life cycles. The orders allow Detroit Edison and Consumers Energy to apply a 10% savings adder for measures with a life of 10 years or more. Consumers Energy also references these dockets, stating, "This adder recognizes the value of the long-life measures by producing additional credit toward the statutory first-year savings targets." Consumers Energy recommends that Michigan continue to focus on first-year savings, but also supports these considerations of lifetime savings.

While EERS statutes typically focus on first-year savings, both NRDC and Consumers Energy note that utilities account for the entirety of a program's lifecycle in the economic benefit-cost assessment of energy efficiency programs. NRDC explains that cost-effectiveness tests are performed on the basis of full lifetime energy savings. Consumers Energy confirms that utilities and regulators judge lifetime savings, but clarifies that the outcomes of the benefit-cost tests for measures and programs are then converted to first-year savings targets.

The utility joint response to question 13 reviews Michigan's spending caps at 2% of revenue (MCL460.1089(7)), and compares Michigan to two other states with formal spending caps on energy efficiency programs.[14] The utilities look favorably upon spending caps:

> Spending caps are important and help balance short- and long-term benefits and costs associated with energy efficiency programs. Standards for energy efficiency programs and related spending caps should be designed in concert with one another and be informed by studies on the energy efficiency potential to ensure the standards are achievable. The standard should fit under an acceptable spending cap to limit short-term impacts on rates.

The utilities also mention a cost cap in Illinois, but this cap is on rate increases, rather than specifically addressing energy efficiency spending. NRDC further explains Illinois' cap:

> The Illinois energy efficiency portfolio standard (EEPS) passed in 2007 does include a hard cap on utility budgets. However, in 2011 the legislature passed complementary legislation requiring the Illinois Power Agency to include in its annual procurement plan for residential and small business customers all energy efficiency investment that is cost-effective over and above the savings from the EEPS, as determined through a utility assessment submitted each year.

NRDC therefore classifies Illinois' approach as a "hybrid" model, bridging caps and "all cost-effective" efficiency program models found in California and Massachusetts. Additionally, the utilities describe seven other kinds of constraints that apply in other states and can serve to limit utility budgets for energy efficiency.[15]

Some commenters question the value of spending caps. These include the MEECC response to questions 3 and 13, which highlight some of the difficulties that budget caps can impose on EO trade partners and ratepayer perceptions. NRDC, in its response to question 13, opines that the combination of budget caps and USRCT evaluations function to "undermine progress toward lowering utility system costs." NRDC concludes,

> [An] effect of the spending caps is to force utilities to focus on low-hanging fruit in order to meet savings targets, as opposed to investing in deeper retrofit programs with longer-term savings.
>
> There is ample evidence that constraining budgets for cost-effective energy efficiency investments is counterproductive and creates enormous lost savings opportunities and unintended consequences in program design and delivery.

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14 These states are Pennsylvania, with a 2% cap, and Wisconsin, with a 1.2% cap.

15 The utilities' Joint Response examines fourteen additional jurisdictions with funding constraints: California, Connecticut, Iowa, Maine, Massachusetts, Minnesota, New Jersey, New Mexico, New York, Ohio, Oregon, Rhode Island, Vermont, and Washington, D.C. (DSIRE, 2012). The different categories of cost constraints the utilities identify include: commission approval of budgets, commission setting the energy efficiency charge, statutes setting the energy efficiency charge, spending minimums, commission budget constraints, consideration of rate impacts, and caps per customer.

The utilities express the importance of spending caps, noting that caps serve to limit short-term rate impacts and help maintain affordable rates. The caps, according to their Joint Response, help balance the short and long-term costs and benefits associated with efficiency programs. The Joint Response notes that the cost of achieving efficiency savings is increasing over time.[16] As these programs continue, the utilities stress that caps should be developed with consideration of overall energy efficiency standards, and that standards should remain achievable given the compliance timeframe and funding limits.

[16] The cost and potential savings from future energy efficiency measures is further discussed in responses to question 10.

IV. Identifying and Quantifying Benefits and Costs from EO

A. Overview

As shown in Figure 1 and Table 3, sixteen comments focus on this topic, and most were submitted in response to questions 2, 5, 6, and 7. These comments center on: (1) whether the current tests used by the Commission are appropriate, and if not, what changes state policymakers might entertain; (2) the potential future benefits of EO programs; and (3) reliability and other non-traditional benefits of energy efficiency. The comments reflect a general agreement about appropriate benefit-cost tests and several comments agree that energy efficiency improves system reliability. Less agreement exists over the potential of energy efficiency in the years ahead. Utility comments express concerns that future energy efficiency initiatives will not be as cost-beneficial as the existing ones, but comments from some interest groups expect continuing and even expanded future, cost-effective EO potential.

B. Benefit-cost tests

Utilities can apply different benefit-cost tests to evaluate EO programs. Each test measures benefits and costs from a single perspective. One test, for example measures benefits and costs from the participating customer's perspective while another focuses on the utility's perspective. Michigan law requires utilities to use the utility system resource cost test (USRCT), or what other states often refer to as the utility cost test (UCT) or program administrator cost test (PACT). Consequently, multiple commenters refer to the USRCT.[17] Michigan law both defines this benefit-cost test (MCL460.1013(d)) and directs the MPSC to determine whether each energy provider's EO plan that satisfies the USRC test is reasonable and prudent (MCL460.1073).

The utilities' joint response to question 2 includes a summary of the USRCT and a helpful review of Michigan documents that is responsive to this question. The Synapse report (Malone *et al*., 2013, p. 4) explains:

> The [USRCT] includes all of the costs and benefits experienced by the utility. It includes all the costs incurred by the utility to implement efficiency programs, and all the benefits associated with avoided generation, transmission and distribution costs. This test is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs. This test provides an indication of the extent to which utility costs, and therefore average customer bills, will be reduced by energy efficiency.

As the utilities note, more states use the total resource cost (TRC) test as the primary benefit-cost test for deciding on energy efficiency programs. The TRC test includes the customer

17 This benefit-cost test is one of a series of standardized tests, as explained in the *Standard Practice Manual* most recently published by the California Energy Commission, 2001.

share of energy efficiency costs, which is not included in the USRCT. As expressed in the Synapse report (Malone *et al*., 2013, p. 4), the TRC test "offers the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the participating customer." Thus, the USRCT is more favorable toward EO programs, since compared with the TRC test it calculates a higher benefit-to-cost ratio for the same EO programs.

While the MPSC relies on the USRCT as the primary test for evaluating EO programs, the utilities explain that Michigan EO planners also use other tests (i.e., secondary tests) to evaluate EO programs, including the TRC test, the ratepayer impact measure (RIM) test, and the Participant Cost test. No commenters explicitly advise about the appropriate role for secondary tests in EO policy decisions.

Comments do not reflect major disagreement over what kinds of documents policy makers should review to determine the cost effectiveness of the current energy-efficiency programs. Several comments refer to the evaluation analysis and reports, developed by independent energy program evaluators and compiled in reports produced by the utilities, by Efficiency United, [18] and by the MPSC. Commenters did not note any problems from relying on differing data sets or sources in making observations or reaching conclusions about EO programs.

The Nature Conservancy refers to several studies from the Lawrence Berkeley National Laboratories that estimated costs and savings from state energy efficiency programs. The most recent of these studies is *The Future of Utility Customer-Funded Energy Efficiency Programs in the USA: Projected Spending and Savings to 2025*.[19]

The Joint Response comments that utilities and electric and gas cooperatives evaluate EO programs in reports submitted to the state program administrator, Efficiency United and by the MPSC in its supervisory role over the state administrator contract. In other words, utilities complete cost-effectiveness tests and commissions review them during the process of selecting measures and designing programs. The review process also includes independent cost-effectiveness evaluations of program operations and outcomes. These evaluations (1) measure and verify the results achieved and (2) study the delivery process "to ensure that programs are operated effectively and identify opportunities for enhancement." Subsequently, the MPSC analyzes and summarizes these reports annually.[20] The Commission has thus far concluded that Michigan's EO programs are cost-effective.[21] Summaries of annual costs and energy savings, along with program evaluations, are included in these reports.

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[18] Efficiency United delivers energy optimization services to customers on behalf of twenty of Michigan's smaller natural gas and electric utility companies, including investor-owned, municipal, and cooperative (member-owned) utilities. See http://www.efficiencyunited.com/.

[19] See http://emp.lbl.gov/publications/future-utility-customer-funded-energy-efficiency-programs-united-states-projected-spend.

[20] *See* MEGA response to Energy Efficiency Question No.1.

[21] Both Efficiency United and MPSC reports are indexed at this web page: http://www.michigan.gov/mpsc/0,4639,7-159-52495_53472---,00.html.

The Joint Response mentions that the USRCT, which is the primary test used in Michigan, is a credible measurement of the cost effectiveness of EO programs. The utilities point out that the USRCT is simpler than other tests and requires only data that most utilities have readily available.

The utilities also raise the concern that while EO projects can result in long-term benefits, measures that pass the USRCT can sometimes put upward pressure on rates in the near term.[22] That can happen if the measures pass the USRCT but not the RIM test; the utilities contend that this outcome should factor into utility planning and policy development.

Naomi, in a response to question 2, recommends a review of the "best practices" methods for measuring the cost-effectiveness of energy efficiency, as described in the *National Action Plan for Energy Efficiency*.[23] As expressed by the authors, this widely-disseminated document "reviews the issues and approaches involved in considering and adopting cost-effectiveness tests for energy efficiency, including discussing each perspective represented by the five standard cost-effectiveness tests and clarifying key terms."

Finally, NRDC states, in response to question 2:

> Section 73(2) of PA 295 requires that each utility's portfolio of programs be cost-effective as determined by application of the utility system resource cost test (USRCT) which compares the total cost to the utility of administering and delivering the programs, to the total generation, transmission and distribution costs avoided by the programs. This test looks at cost-effectiveness from the perspective of the utility system, and therefore *does not take into consideration the value of environmental improvement, the value of the added comfort or convenience to the customer, any macro-economic benefits (e.g. job growth) or any societal benefits created by the programs.* Even omitting consideration of these critical energy efficiency benefits, however, the programs have created substantially more benefits than costs. [Emphasis added]

NRDC contends that the Michigan utility EO portfolios have been extremely cost effective, even when excluding pertinent benefits, as demonstrated in different reports and utility reports filed with the Commission. For example, an MPSC report aggregated the savings results from all of the state's electric and gas utilities and calculated that for every dollar spent by the utilities, consumers will save an estimated $3.55. The MPSC report also estimates the total

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22 The test that assesses the effect of changes in revenues and operating costs caused by a program on customers' bills and rates is the rate impact measure or RIM.

23 The *National Action Plan for Energy Efficiency* (NAPEE) was a public-private collaborative effort from 2005-2010, facilitated by the U.S. Environmental Protection Agency and Department of Energy, including input from gas and electric utilities, utility regulators, and other partner organizations. The project resulted in the publication of several reports, including best-practices recommendations for utility energy efficiency programs. See http://www.epa.gov/cleanenergy/energy-programs/suca/resources.html.

lifecycle savings for all utility measures for expenditures made during 2011 as $709 million.[24] NRDC remarks that including reliability and environmental benefits from EO programs would increase the value of the annual savings to more than $1 billion per year. Preliminary data for 2012 indicates similar results.

C. Energy efficiency potential

Joint Response comments discuss how EO measures and programs are explored in a logical sequence, analyzing technical, economic, achievable, and program potentials. The utilities believe that EO activities become progressively more constrained over time, by factors such as cost-effectiveness, customer willingness to participate, and program delivery limitations.[25]

Other commenters, however, believe that EO measures will continue to be highly economical. For example, Nature Conservancy's response to question 10 states:

> [S]eparate studies by the McKinsey & Company (2009), the National Academy of Sciences (2010), and the Alliance Commission on National Energy Efficiency Policy (2013) indicate that the potential for energy efficiency is substantial. Electric consumption can be reduced by 20 to 25 percent using technologies that are available today and that will save consumers more on their utility bills than the initial investment in more efficient buildings and appliances. However, policies to remove market barriers (such as inadequate consumer information) described in the reports are needed to realize the full potential.

NRDC concurs, saying:

> All available evidence suggests that Michigan utilities should be able to ramp up to a level of annual electric savings equal to 2% of sales, roughly double what they are currently planning to achieve in 2013.

NRDC proposes that, instead of relying on energy-efficiency potential studies, policy makers should examine the activities of the most proactive states in promoting energy efficiency. Although recognizing the differences between jurisdictions, NRDC holds that the long experiences of those states with energy efficiency programs are "highly unlikely to dramatically affect the transferability of results, at least between states with roughly similar climates."

The Michigan Public Service Commission, DTE Energy and Consumers Energy worked together to complete a study in 2013 of energy efficiency potential in the state of Michigan. The draft potential study was made available for stakeholder comment on October 9, 2013. The draft report, "Michigan Electric and Natural Gas Energy Efficiency Potential Study" is included as

[24] *2012 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs*, Michigan Public Service Commission Dept. of Licensing and Regulatory Affairs, November 30. 2012.

[25] These issues are discussed in part V.B. of this report, beginning on page 31.

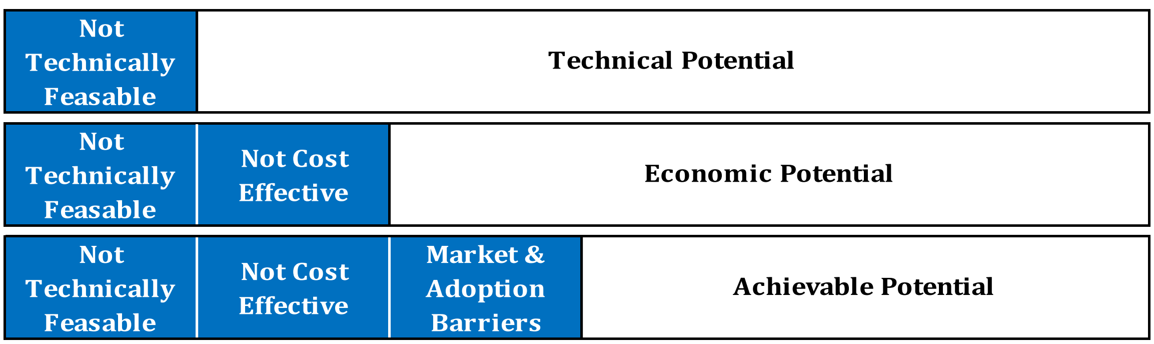
Appendix B. As reported by GDS Associates, the study examines the potential to reduce electric consumption and peak demand and natural gas consumption through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in Michigan. This study assesses electric and natural gas energy efficiency potential in Michigan over ten years, from 2014 through 2023.

The study had the following main objectives:

- Evaluate the electric and natural gas energy efficiency technical, economic and achievable potential savings in the State of Michigan;
- Calculate the economic and achievable potential energy efficiency savings based upon cost effectiveness screening with both the TRC and UCT benefit/cost ratios.

As noted above, the scope of this study distinguishes among three types of energy efficiency potential; (1) technical, (2) economic, and (3) achievable potential. The definitions used in this study for energy efficiency potential estimates were obtained directly from a 2007 National Action Plan for Energy Efficiency (NAPEE) report. Figure 1-1 below provides a graphical representation of the relationship of the various definitions of energy efficiency potential.

Figure 1-1: Types of Energy Efficiency Potential[26]



Limitations to the scope of study: As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions and data sources, including the following:

- Energy efficiency measure lives, measure savings and measure costs
- The discount rate for determining the net present value of future savings
- Projected penetration rates for energy efficiency measures
- Projections of Michigan specific electric and natural gas avoided costs
- Future changes to current energy efficiency codes and standards for buildings and equipment

With respect to non-energy benefits of energy efficiency programs, GDS did include an adder of $9.25 per ton of carbon for reduced emissions of CO_2. Also, there was no attempt to place a dollar value on some difficult to quantify benefits arising from installation of some measures, such as increased comfort or increased safety, which may in turn support some

[26] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

Summary of Key Findings in the Draft Potential Study

- This study examined 1440 electric energy efficiency measures and 811 natural gas measures in the residential, commercial and industrial sectors combined. The MPSC staff, utilities in Michigan, and stakeholder organizations all had input to the list of measures examined in this study.
- For the State of Michigan overall, the *economic* potential for electricity savings over the next ten years (2014 – 2023) ranges between 31% and 35% of forecast kWh sales for 2023. The *achievable* potential for electricity savings over the next ten years (2014 – 2023) is a range of 14.5% to 16.1% of forecast kWh sales for 2023.
- For the State overall, the *economic* potential for natural gas savings over the next ten years (2014-2023) ranges from 18.7% to 30.7% of forecast MMBtu sales for 2023. The *achievable* potential for natural gas savings over the next ten years (2014 – 2023) is a range of 10.5% to 14.7% of forecast MMBtu sales for 2023.

The Draft Potential Study is included as Appendix B.

D. Unaccounted for benefits in traditional benefit-cost tests

A few commenters identify benefits from EO programs that most benefit-cost tests do not take into account. These benefits include improved utility reliability and a cleaner environment, in addition to customer-specific benefits. Some comments suggest additional considerations of cost-effectiveness:

- NRDC notes several additional benefits from EO programs, which are not included in the USRCT, including “environmental improvement, the value of the added comfort or convenience to the customer, any macro-economic benefits (e.g. job growth) or any societal benefits created by the programs.” NRDC also cites the likelihood of additional, uncounted “reliability” benefits.

- MEECC recommends that cost effectiveness should consider the vantage point of the contractors who do energy efficiency work. MEECC expresses the value of including contractors in utility program design, explaining:

> Because of their intimate knowledge… contractors know ways to improve energy efficiency programs to make them less costly for utilities and more profitable for themselves. Energy efficiency contractors can help find ways through collaboration

with utility energy efficiency program designers to increase the cost effectiveness for all stakeholders."

- ACEEE cites electric energy savings data from an MPSC (2012) report and uses that data to estimate environmental emissions reductions associated with those EO efforts, as calculated using the U.S. EPA Power plant Emissions Calculator (EPA, 2012). It estimates that achieving equivalent emissions reductions through pollution control equipment alone would cost over $1 billion, and points out that the estimated environmental benefits are in addition to the economic benefits already identified in the MPSC (2012) report.

- Both ACEEE and NRDC refer to benefits in the form of reduced greenhouse gas emissions, and discuss other jurisdictions' estimates of the value of avoided greenhouse gas emissions, in the absence of any state or federal policies that would assign an explicit value.

- NRDC provides estimates of the economic benefits it forecasts for Michigan at both a 1% and 2% electricity efficiency standard. NRDC discusses how energy efficiency improvements can defer transmission and distribution upgrades, citing evidence of these effects from New York, New England, and California.[27]

The commenters generally agree that energy efficiency efforts can improve reliability by reducing stress on the transmission and distribution (T&D) system. The Joint Response says, for example, "[E]nergy efficiency can be considered part of the [utilities'] proactive efforts to prevent reliability problems." The utilities note that energy efficiency programs are not directly tied to the utilities' other reliability improvement activities, but energy efficiency can act as a "proactive reliability method" by reducing overall energy consumption and peak demand. It added that only a few jurisdictions have used targeted energy efficiency measures to alleviate short-term local reliability issues.

Both the utilities and NRDC refer to geographically-targeted (or geo-targeted) energy efficiency programs that would focus on those areas where current limits to generation or transmission capability result in localized reliability concerns. In particular, existing geo-targeted energy efficiency programs in Vermont (Navigant, 2012) and New York City (citation, not included in utility comments) are cited by the utilities. NRDC refers to reports by Lazar and Baldwin (2011) and Neme and Sedano (2012).

The Joint Response refers to conservation voltage reduction (CVR), which is a utility-side energy efficiency opportunity, especially for heavily loaded distribution circuits. NRDC notes that energy efficiency improvements can result in savings due to line-loss reductions and capacity reserves, too.

The Joint Response discusses reliability in terms of outages, only, and does not mention power quality issues. James's comment refers to an expanded definition of reliability that

[27] See Gazze and Massarlian, 2011; George and Rourke, 2012; and Neme and Sedano, 2012.

includes more than simply the number and duration of utility outages. The general concern is that modern electronic equipment power quality requirements are different and higher than previous electric appliances. Even modest power-quality deviations can eventually cause problems for electronic devices, and even momentary outages can generate extensive costs for various kinds of end users (especially for computer aided manufacturing and for manufacturing processes that have to waste resources that are in production when any outage occurs).

NRDC remarks that considerable evidence supports the improved reliability that derives from energy efficiency. NRDC also recommends three ways for utilities to maximize the reliability benefits of energy efficiency. They are: (1) measurement of marginal line-loss rates, (2) measurement of passive deferrals of T&D upgrades, and (3) least-cost planning for T&D.

NRDC concurs with the comments of the Joint Response. NRDC states:

> The reliability enhancing benefits of energy efficiency have been extensively documented. Recently, the Regulatory Assistance Project produced two papers detailing the value of energy efficiency investments to reducing peak demand, reducing line-loss, reducing the cost of capacity reserves and reducing the need for new investment in distribution infrastructure.[28]

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[28] Jim Lazar and Xavier Baldwin, *Valuing the Contribution of Energy Efficiency to Marginal Line Losses and Reserve Requirements*, August 2011, and Chris Neme and Rich Sedano, *U.S. Experience with Efficiency As a Transmission and Distribution System Resource*, February 2012.

V. Alternatives for Improving Michigan EO Programs

A. Overview

Nearly one-quarter of all the comments about energy efficiency include alternatives for improving Michigan's EO programming. Some of the comments recommend including specific devices and emerging technologies in utility EO program offerings. Examples include flue-gas heat recovery systems, combined heat and power systems, and earth-coupled, water-source heat pumps that are commonly referred to as "geothermal."[29] Other comments provide more general EO programming alternatives. Examples include proposals for:

- Linking energy efficiency improvements for residential properties at the time of sale, and recommending provisions for special energy efficiency financing that would be available at the time of sale;[30]
- Benchmarking building energy performance, with something like a miles-per-gallon rating that could be easily understood by building owners and managers;[31]
- Providing customers with more detailed and timely data that customers could use to better tailor their energy use to reflect utility system costs that vary in response to the timing of consumer demands;[32]
- Upgrading building codes and standards to what is presently a voluntary, high-efficiency buildings energy standard known as "Passive House" (Passive House Institute US, 2011);[33] and,
- Encouraging state facilities to adopt the "Architecture 2030 Challenge," which is a voluntary energy efficiency buildings standard which calls for new buildings built by 2030 to use no fossil fuels.[34]

Other themes addressed in the comments include:

- Retaining flexibility and adaptability in EO programming;

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29 These include comments about flue-gas recovery systems from Sidel Systems USA, Inc., in response to question 1, about geothermal systems from Ryan, Thermo Source in response to question 10, and about CHP from Dow Chemical and NRDC in response to question 10. NRDC cites its published *Issue Paper* report, by Gowrishankar *et al*., 2013. Dow's response also mentions benefits from insulation and air-sealing.

30 Comment from Lee, ASME, in response to question 2.

31 Comment from Thom, in response to question 10, suggesting a metric of Btu/square-foot, per degree-days. Heating degree days is a commonly-used measure of weather-related energy demand for heating. A related measure for air conditioning demand is cooling degree days.

32 Comments by MiEIBC in response to question 19 and comments by Scott in response to question 9.

33 Comment from James, in response to question 5.

34 Comment from Joann, GLREA, in response to question 6, which indicates that Illinois, Minnesota, Ohio, and the National Governors Association have adopted this standard.

- Improving EO opportunities for all customer classes, with special attention to low-income programming;
- Leveraging additional, private sources of funding for EO;
- Coordinating EO program offerings for both gas and electric utilities;
- Including non-traditional EO efforts to produce utility system benefits; and,
- Integrating EO with utility business models.

Each of these themes is reviewed in more detail in the following sections.

B. Retaining flexibility and adaptability in EO programming

Michigan utility company comments, in particular, cite flexibility and adaptability as important concerns for future EO programs. In responses to questions 3, 7, and 10, utilities express concerns that energy efficiency is an exhaustible or depleting resource, thus suggesting that flexibility in goals and spending could be required. The utilities' joint response to question 10 states, "Future savings… are likely to be somewhat more expensive to achieve than in the past." And, the joint response to question 7 reports, "DTE Energy estimates it will cost 2.9% of its electric revenue by 2015 and 4.3% by 2020 for each 1% of savings." The utilities point out challenges associated with continuing to meet Michigan's EO standard in a cost-effective manner and within the budget of the legislated 2% cap on utility revenues. For example, DTE Energy predicts higher costs and limited growth in savings for its electric EO program efforts in 2013 through 2015. DTE cites these challenges:

- gradually tightening evaluations of energy efficiency measure and program savings being used in Michigan, including adjustments to account for "free riders;"[35]
- gradually tightening federal mandatory manufacturing standards for appliances and lighting;
- reduced forecasts for future avoided energy costs associated with lower power and capacity prices in Michigan's and the region's electricity markets;
- increasing difficulty in attracting program participants once early adopters have taken advantage of program offerings; and,
- the success of programming in the early years reducing the potential pool of future savings to be tapped.

Bill's response to question 2 also notes a proposed progression in the stringency of Michigan's energy efficiency construction code. He relates the need to verify the accuracy of predicted energy savings and evaluate the cost-effectiveness of incremental efficiency expenditures in buildings. The GDS study (2013a, p. 37) includes a discussion of similar factors, under the rubric of "naturally occurring conservation."

[35] The term "free rider" refers to "Participants in an energy efficiency program who would have adopted an energy efficiency technology or improvement in the absence of a program or financial incentive" (GDS, 2013a, p. 10).

Consumers Energy cites some of the same challenges, and both Consumers Energy and joint utility comments identify the importance of the newly published study of Michigan's energy optimization opportunities (GDS, 2013a). Consumers Energy states:

> There is [a] critical need for a comprehensive and industry peer reviewed potential study which accounts for the current baseline conditions, efficiency gains to date, changing codes and standards, as well as up-to-date deemed savings values in order to properly forecast remaining efficiency potential in Michigan.[36]

The joint response to question 10 concludes:

> A current and rigorous energy efficiency potential study for the state of Michigan that factors in the latest changes in baselines, Michigan Energy Measures Database deemed savings values, and codes and standards, as well as other criteria identified by interested stakeholders, would best serve to inform the planning process.

In contrast to the utility's point of view about challenges associated with continuing to achieve or exceed EO standard goals while maintaining spending below current caps, some responses from other parties claim that Michigan could do more. For example, both NRDC and MEECC assert that Michigan could easily double its efficiency standard to 2% per year. In its response to question 3, MEECC states unequivocally that the Michigan standards can be met through 2015. It says that meeting the current standard is "no problem… [and] even higher levels of savings can be achieved." Reports cited in support of this contention include broad-based energy efficiency studies from the Alliance to Save Energy (2013), Electric Power Research Institute (2009), McKinsey & Company (Granade *et al*., 2009), and the National Academy of Sciences (2010). Some of those studies conclude that a large potential remains for achieving cost-effective energy optimization. Also, MLUI provides an excerpt from an Efficiency Vermont report, purporting to show energy efficiency savings as a percent of Vermont's electricity needs from 2000 through 2010, and indicating performance in the past few years achieving savings greater than the existing Michigan standard of 1%.[37] MEECC cites as evidence Michigan's state-wide program evaluation reports (Efficiency United 2012, MPSC 2012a, and MPSC Staff 2013), which MEECC says show that Michigan's EO standards have been surpassed each year.

MEECC also reports that Michigan utilities are "rationing" EO, as a means of keeping within program budgets, but also with the result of obtaining less than the readily-achievable potential. According to MEECC, one Michigan investor-owned utility (IOU) is reducing "incentive and rebate levels to extend the life of its energy efficiency programs" and another

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36 In estimating costs and energy savings, Michigan energy efficiency program administrators and evaluators utilize a shared "deemed savings" database, called the *MI energy measures database*, which uses data from engineering calculations and actual experience to estimate savings from specific energy efficiency measures. See MPSC, 2013.

37 Jim's comment, on behalf of MLUI, refers to providing information from "several studies," but only the single page from Efficiency Vermont is attached. Additional related information is included in the MLUI presentation from the April 22 forum in Traverse City, which is linked here: http://www.michigan.gov/documents/energy/6_-_MLUI_LCV_Voss_418818_7.pdf

IOU “will be turning off its energy optimization program in June.” “Both IOUs,” says MEECC, “publicly cite high-paced uptake of energy efficiency upgrades by ratepayers as the reason to reduce incentives or close their program.” MEECC explains that Michigan’s EO spending cap creates problems for energy efficiency contractors:

> Having to reduce rebates or shut down programs causes significant internal restructuring of direct utility staff and implementation contractors hired to design and manage these programs. In the case of reduction, new marketing pieces and campaigns have to be launched; trainings conducted and handled an increase in customer service calls. All of this adds to the cost of administering the programs, thus reducing the amount of savings that could otherwise be achieved.

NRDC is also critical of spending caps. It concludes that spending caps force utilities to make investments on less cost-effective resources, encouraging utilities to focus more exclusively on “low-hanging fruit,” rather than long-term savings programs. NRDC introduces a study that models savings for Pennsylvania utility customers in capped and un-capped scenarios. This study (Optimal Energy, 2011) found that customers would save $932 million in a capped scenario, and $1.6 billion without a cap.

NRDC comments also make note of the newly released statewide energy efficiency potential study (GDS, 2013a). However, NRDC also points out some of the difficulties inherent in assessing the statewide achievable potential. NRDC states:

> Moreover, efficiency potential studies have important limitations that tend to lead to systematic under-estimates of achievable potential. Perhaps most notably - and by definition - they cannot fully account for the emergence of new technology, new services, or new efficiency program designs that will increase the savings that will actually be able to be achieved in the future.

Thus, NRDC suggests, “[W]hile efficiency potential studies can provide some valuable insights, it is likely more instructive to examine what leading jurisdictions are actually achieving and/or planning to achieve in the near future.”

As the GDS study (2013a, p. 34) of Michigan’s EO potential confirms:

> The study scope includes measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures are of the most immediate interest to DSM program planners in Michigan. However, a small number of well documented emerging technologies were considered for each sector. Emerging technology research was focused on measures that are commercially available but may not be widely accepted at the current time.

Another subject that multiple commenters target for flexibility and adaptability is about how standard benefit-cost tests are applied during EO program planning. Responding to question 2, both Chuck and Naomi refer to documents produced by the National Action Plan for Energy Efficiency (2006, Chapter 6), which they say review best-practices in cost-effectiveness testing. The GDS report (2013a, p. 45) includes a primer and Synapse report (Malone *et al*., 2013) provides more extensive explanations about benefit-cost testing. DTE Energy in responses to questions 14 and 16 explains that the Utility System Resource Cost Test is the primary one used in Michigan, based on assessments of utility costs compared to first year energy savings. As DTE and other parties point out, the requirement for use of the USRCT is incorporated in Michigan's *Clean, Renewable, and Efficient Energy Act* (MCL 460.1073).

Some of the emphasis on flexibility comes in response to question 16, which asks about addressing "long-lifecycle programming such as interest rate buy-downs, home performance programs, industrial whole process programs, and deep savings programs for business customers." The difficulty in pursuing such programs in the context of a utility ratepayer funded EO program is that their inherent program costs can be high relative to first year energy savings. DTE comments,

> [L]ong-lifecycle programs like home energy consultation and weatherization are less cost effective (higher cost per MWh saved) in comparison to other programs in the portfolio. When compared based on <u>lifetime savings</u>…deep savings programs remain the most expensive options.

Consumers Energy discusses some of the deep savings programs that Michigan's utilities offer. According to Consumers Energy, these include a *Home Performance with Energy Star* bonus for residential retrofits and Michigan Saves^{SM} financing which provides interest-rate buy-downs for energy efficiency loans. Consumers Energy also mentions its pilot program, called the *Multiple Measure Pilot*, which offers incentives when multiple energy efficiency measures are applied for simultaneously. Consumers Energy offers this as an example of a graduated incentive program, and expresses the goal of encouraging deeper project savings. In this context, Consumers Energy also mentions property-assessed clean energy (PACE) financing and provides a table that compares deep savings programs in other jurisdictions, including California, Connecticut, District of Columbia, Maryland, New Jersey, and Wisconsin. These programs vary in requirements and incentives. As many of these examples demonstrate, public-private partnerships that create easy access to inexpensive energy efficiency financing can be essential elements for successfully packaging deep-savings projects so that they pass the USRCT.

C. Improving EO opportunities for all customer classes, with special attention to low-income programming

Several comments focus on alternatives for improving EO opportunities for specific customer classes.

Responses from 5 Lakes Energy and SunSpace Energy Systems focus primarily on the residential sector. Both commenters point to the US Department of Energy's "Home Energy Score Team" pilot program. This program models and assesses household energy efficiency and performance. Both commenters recommend that Michigan should monitor this program as it continues to develop. Michigan Energy Options says it is a current partner in this program, and is "working with DOE towards the standardization of metrics on home and commercial performance programs in the state of Michigan."

Comments from Thom, in response to question 10, describe successful experience with a sequence of energy efficiency investments in the Grand Rapids Public Schools.

ABATE comments in response to question 8 recommend extending to all industrial customers the opportunity to opt for self-directed plans. ABATE suggests this would enable greater efficiency in program implementation.

MEECC comments describe how energy savings are often "left on the table" during energy efficiency work, where some of the opportunities already identified might not be pursued. MEECC opines that a 2% energy-savings standard can be secured "very easily and with existing technology." "The issue," MEECC says, "is to get into more housing units and businesses."

Question 20 asks about the impact in Michigan and other jurisdictions of retail choice electricity markets. MiEEBC provides the only response to this question, and notes that:

> [T]here is not a fundamental conflict between retail choice and energy efficiency policy… [and] most… retail choice states have specific energy efficiency resource standards, similar to Michigan's Energy Optimization Standard.

Michigan alternative energy suppliers are not prevented from offering EO services to their customers. Large industrial or commercial customers can opt to implement a self-directed EO plan, which can enable an alternative supplier to provide them with energy optimization services. Further research would be needed to examine what, if any, efficiency programs are offered by alternative suppliers.

Additionally, Michigan Energy Options raises the issue it calls "split fuel," which arises when a customer has one utility delivering electricity and another delivering natural gas. Although some Michigan consumers receive both gas and electricity from a single provider, either Consumers Energy or DTE Energy, many others have one company providing electricity and another providing natural gas. This, in Michigan Energy Options' opinion, can result in confusion about EO program offerings, making it more difficult for customers to engage. Michigan Energy Options calls for greater coordination between utilities.

The utility joint response to question 18 concludes by stressing that low-income weatherization programs are important, and have financial and social benefits beyond the energy savings offered. The utilities recommend that funding for these programs remain flexible, leverage all available funding sources, and continue to provide benefits to both utilities and customers.

D. Leveraging additional, private sources of funding for EO

In response to question 6, MiEIBC notes efficiency efforts can benefit by using limited ratepayer funding to leverage additional private-sector funding and low-cost financing. Better World Builders, in its response to question 9, echoes this sentiment with a specific endorsement of the Michigan Saves^{SM} program. Better World Builders' comments stress the importance of rebates and loan programs for energy efficiency retrofits. And, Thom's response to question 10 provides a reference to the US Department of Agriculture's Rural Energy for America Program (REAP), suggesting it is an example of an underutilized incentive program which could be another source of non-utility funding.

In this context, it should be noted that the GDS study of Michigan EO potential is based on a standard EO funding model where utility ratepayer funding provides 50% of the incremental cost of higher energy efficiency measures. As the comments on this subject suggest, there can be other means of attracting customer attention and financing improvements. To the extent that utility ratepayer funding can be stretched further by creatively combining utility incentives with other public and private programs, more EO can be achieved within existing spending caps and passing the USRCT.

E. Including non-traditional EO efforts to produce utility system benefits

Questions 15 and 19 are especially focused on non-traditional EO efforts and producing utility system benefits. Comments on these topics were submitted by Consumers Energy, Dow Chemical, DTE Energy, MECA, MiEIBC, the Nature Conservancy, and NRDC.

No commenters analyze the effect of including or not including non-traditional energy efficiency in utility EO programming. Instead, the responses examine various types of non-traditional proposals and make suggestions for further opportunities. Questions to be addressed by policy makers could include the extent to which non-traditional EO might be included in utility EO programming budgets and goals or whether and how to include non-traditional efforts by some other means.

Consumers Energy details some jurisdictions with peak-shaving initiatives.[38] And, Consumers Energy reports that in other states, specific utilities have received Commission approvals for peak-clipping programs without there being a specifically-related energy efficiency program mandate.[39] Consumers Energy discusses a 2007 study that assessed wholesale price savings resulting from peak shaving. This study found a price reduction of 5%-8% with a 3% reduction in peak load for the PJM interconnection (The Brattle Group, 2007). Consumers Energy says that another study by the Brattle Group and a Pennsylvania assessment of wholesale price and cost effectiveness are forthcoming (GDS Associates, 2013a and The Brattle Group, 2010).

Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives.[40] Consumers Energy discusses difficulties in implementing demand reduction programs under Michigan's existing EO programs structure and incentives. Michigan's EO program does not, in Consumers Energy's opinion, allow proper incentives for demand response programs. Consumers Energy says that

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[38] These jurisdictions include Delaware, Illinois, Maryland, New Jersey, Ohio, and Pennsylvania.

[39] These jurisdictions include Indiana, Virginia, and Wisconsin.

[40] http://energy.gov/oe/technology-development/smart-grid/demand-response

demand response programs do not qualify for EO incentives, and would make it more difficult for utilities to meet their efficiency targets.

DTE Energy agrees with this assessment of demand response programs:

> [I]f an energy optimization plan included investments in demand response, those investments would proportionately increase the energy savings targets for electric providers according to the provisions in PA-295. This has become a significant barrier for including demand response in energy optimization plans. Michigan PA-295 stipulates that if an electric provider uses demand response to achieve energy savings under its energy optimization plan, the minimum energy saving requirements need to be increased so that the ratio of the minimum energy savings to the total program expenditures including both general energy efficiency and demand response remains constant…This has become a significant barrier for electric providers in Michigan to justify the inclusion of demand response programs in their energy optimization plans.

However, DTE Energy reports it has already implemented some demand response programs. DTE Energy estimates the peak-reduction capability of its existing programs is 584 MW. The utility notes that the cost of demand response programs can be compared to the cost of purchasing capacity from the market or building new generating capacity, and that demand response programs will continue to develop, given economic justification.

NRDC posits that savings produced during times of peak demands will prove more cost-effective due to the higher avoided energy and capacity costs. NRDC also discusses MPSC Case No. U-17049, which allows a 1% incentive for peak savings. NRDC's opinion is that peak reductions should not be emphasized over other energy efficiency investments. NRDC states, "The best peak demand reduction strategies are energy efficiency strategies, not load-shifting."

The Nature Conservancy provides two studies that address the cost effectiveness of demand response programs (Hornby, 2011, and Woolf, 2013). These studies provide a framework for cost-effectiveness tests and an estimate of potential savings achievable through demand response techniques. Additionally, DTE Energy provides studies performed by Consolidated Edison Company of New York and the Public Service Commission of Maryland (Consolidated Edison Company of New York, 2012, and Public Service Commission of Maryland, 2012). These studies also address demand-response cost-effectiveness, but DTE Energy cautions that variations in methodology make it difficult to directly compare the results of different studies.

MECA's response discusses the opportunity to decrease system losses. According to MECA, Arkansas, Florida, Iowa, Massachusetts, Maryland, Minnesota, New York, and Vermont include transmission and distribution savings in their EERS. The response estimates that utilities lose from 2% to 15% of generation purchases to line losses. MECA suggests that efficiency savings from decreasing line losses should be a focus for utilities. MECA introduces a report, entitled "Marginal Line Losses," to further detail line losses and technological responses.

The joint utilities detail some other non-traditional programs undertaken by Michigan utilities. These include a "Web Portal Solution," which provides customers with information about energy consumption and comparisons to other customers, and "Smart Energy Drives," which works with community organizations to enroll a number of customers in energy efficiency programs. DTE Energy and Consumers Energy are also developing an Advanced Metering Infrastructure (AMI) and Smart Grid program. The utilities identify some benefits that these systems will allow:

- Deferred capital expenditures and improved asset utilization;
- Reduced generation and environmental impacts; and
- Increased options for managing energy consumption and costs.

These advantages will allow the utilities, in their estimation, to increase energy efficiency savings between 56 and 203 billion kWh by 2030 (Gelling, 2009). MiEIBC endorses the availability of customer data, and points to the White House's "Green Button Initiative." This program encourages utilities to provide customer data on the internet. MiEIBC notes that no Michigan utility has announced participation in this program, but MiEIBC encourages an effort to make advanced-metering data available to customers. Beth's response also focuses on the availability of customer usage data. She suggests that greater consumer awareness will help consumers to lower their electricity usage.

A joint utility response also examines "conservation voltage reduction," (CVR) which allows utilities to optimize system voltage. While utilities in Michigan continue to assess the application of CVR, the joint response also notes that CVR is already being utilized in some other states.[41] MiEIBC expands upon the advantages of CVR, quoting a U.S. DOE report (2012), which reports that CVR can achieve a 4 to 5% reduction in energy consumption.

MiEIBC also addresses the issue of line losses. It suggests the usage of dynamic volt-VAR, which, with the support of real-time sensors, allows utilities to control voltage and reactive power. MiEIBC also identifies opportunities for further efficiency in power generation. MiEIBC explains:

> The premier example is the use of combined heat and power, in which the heat produced to generate electricity is then used either for building heat or industrial process heat. In Michigan, some municipal utilities operate in this fashion with heat provided to customers through a district heating system. … According to the Michigan Public Service Commission's 21st Century Energy Plan, Appendix II[,] which was the last comprehensive assessment, Michigan has unused combined heat and power potential of more than 675 MW electricity generation capacity.

MiEIBC assesses the efficiency of power generators through the "heat rate" of a facility. This involves a comparison of a facility to similar generators. MiEIBC recommends targeting generators with a high heat rate for targeted efficiency investments.

[41] The joint response points to CVR programs undertaken by PECO in Pennsylvania and Snohomish Public Utility District in Washington.

F. Integrating EO with utility business models

Another important topic addressed in several comments is how best to integrate EO with utility business models. The crux of this issue is that under long-standing, traditional utility regulation and rate structures, utilities' revenues are determined in large part by charges that vary depending on how much energy consumers use. Under this type of system, utilities can be averse to EO, because conservation and efficiency measures reduce consumer usage and thereby cut into utility revenues and profits. Multiple comments discuss revenue decoupling mechanisms (RDM), which are at least a partial antidote to having profits and sales levels tied directly to one another. Multiple comments cite reports published by American Council for an Energy-Efficient Economy, Regulatory Assistance Project, and NRDC (Morgan, 2012); Center for Climate and Energy Solutions (no date); National Action Plan for Energy Efficiency (2007); and National Renewable Energy Laboratory (NREL, 2009).

The Joint Parties cite the NREL report (2009) which defines decoupling as "a rate adjustment mechanism that breaks the link between the amount of energy a utility sells and the revenue it collects to recover the fixed costs of providing service to customers;" and states that a well-designed decoupling policy "reduces the costs of the ratemaking process [and] reduces costs to consumers without affecting the profit rate to investors." NRDC reports that 25 states have adopted decoupling for one or more electric or natural gas utilities.[42]

The comments of the Joint Parties and the NRDC both support the National Action Plan for Energy Efficiency's recommendation (2007) that decoupling could serve as one component of a comprehensive utility-driven energy efficiency program. However, comments from NRDC and echoed by Fred from Great Lakes Energy caution against rate structures which transfer more costs to fixed charges.

The Joint Parties and NRDC both support decoupling as a mechanism to remove, as the Joint Parties state, the disincentive that utilities have to reducing sales of their product. NRDC refers to this as the "throughput incentive" and states that when sales are higher than a sales projection set in a rate case, the utility earns more than its authorized recovery level, and if sales are lower than the projection it can earn less than its fixed costs to operate the system. The Joint Parties characterize decoupling as a "win-win" but cite the Center for Climate & Energy (no date) explanation of the contradiction between conservation and efficiency goals and the way that utility rates are currently structured.

The Joint Parties rely on the US EPA's National Energy Efficiency Action Plan in discussing a combination of multiple types of cost recovery and incentives. Specifically, the Joint Parties focus on:

(1) Program Cost Recovery – reimbursement of the utility's expenses associated with energy efficiency programs, such as the staff to operate them and the cost of energy-savings products offered to customers;

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42 Please see a series of maps indicating the status of state decoupling policies as of May 2013; http://www.nrdc.org/energy/decoupling/

(2) Lost Margin Recovery – compensation for the profit lost as a result of reduced sales of electricity or natural gas; and

(3) Performance Incentives – positive incentives for investment, with opportunities for utilities to earn more by achieving or exceeding specified energy efficiency targets.

According to the Joint Parties, decoupling is one type of mechanism that can be used to achieve lost margin recovery. Further, positive incentives can help ensure that utilities put the same kind of effort and investment into energy efficiency as they do into other aspects of their business where better performance leads to better earnings. The NRDC comments agree, also citing to the National Action Plan, that decoupling is not sufficient, in itself, to create a robust energy efficiency program. However, NRDC discourages particular decoupling mechanism alternatives. NRDC specifically mentions lost revenue adjustment mechanisms, and higher fixed charges in utility rates. NRDC's expressed concern with lost revenue adjustment mechanisms is that they do not eliminate the "throughput incentive," and they are not applied symmetrically in that "found" revenues are generally not refunded to customers. NRDC's expressed concern with higher fixed charges is that they diminish the "price signal" to customers to conserve energy, and increase the payback period for customer investments in energy efficiency, making customer participation in energy efficiency efforts less likely and beneficial.

The joint utility responses and NRDC both reference a 2012 Michigan Court of Appeals decision that denies the Michigan Public Service Commission the authority to approve decoupling mechanism proposals made by electric utilities, while preserving that authority for natural gas utilities.[43]

In light of the Court of Appeals decision, the NRDC comments indicate what the RDM rate adjustments for electric utilities would have been if the proposed decoupling mechanisms had been approved. These adjustments include a 12% reduction in residential rates in the Detroit Edison territory to refund overearnings. The other utilities' adjustments, as reported by NRDC, would have totaled less than 1% in either direction. NRDC also states that Michigan's natural gas utility RDM adjustments have ranged from over 6% downward to 3% upward, though the majority of adjustments have been less than 1% in either direction.

The NRDC comments reference a recent report by Pamela Morgan that concludes, based upon a review of over 1,200 rate adjustments due to decoupling, that adjustments up or down have been modest for both electric and natural gas utilities.[44]

Taken together, the responses and the reports that they cite (in particular, the National Action Plan for Energy Efficiency, NREL, and Morgan reports) offer comprehensive discussions of a variety of decoupling mechanisms as well as examples of rate impacts. These resources

[43] In re Detroit Edison Co. Applications, 296 Mich. App. 101, 817 N.W.2d 630 (2012), holding that PSC exceeded its statutorily granted authority when it authorized the electric utility to adopt a Revenue Decoupling Mechanism (RDM).

[44] Morgan, Pamela. A Decade of Decoupling for U.S. Energy Utilities, Rate Impacts, Designs and Observations. December 2012.

provide data upon which to base a state-wide decoupling policy for electric and natural gas utilities. Regarding electric decoupling, a threshold challenge will be crafting and enacting language that authorizes the Public Service Commission to accept electric utility decoupling programs.

Additional Michigan-based resources that provide a diversity of policy options regarding decoupling include: Report to the Commission on the Revenue Decoupling Mechanism (RDM) Collaborative,[45] and 2012 Report on the Implementation of P.A. 295 Utility Energy Optimization Programs.[46]

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45 Appendix C to this 2011 Report provides a comprehensive matrix of Revenue Decoupling Mechanisms approved by the Commission. The body of the report offers utility and stakeholder viewpoints on the value of the various decoupling mechanisms approved. http://www.michigan.gov/documents/mpsc/decoupling_report2_15_11_345740_7.pdf?20130901164307

46 This Report (Michigan Public Service Commission, November 2012, pp. 16-17) summarizes some of the consequences of the Michigan Court of Appeals 2012 decision (In re Detroit Edison Co. Applications, 296 Mich. App. 101, 817 N.W.2d 630), which caused the Commission to dismiss pending RDM reconciliation cases without a settlement order. In the case of Detroit Edison, the company had a $127 million over-collection due to the RDM with pending reconciliations for years 2010 and 2011 at the time the cases were dismissed. Consumers Energy had an under-collection of approximately $59.6 million due to the RDM with pending reconciliations for years 2010 and 2011 at the time the cases were dismissed. http://www.michigan.gov/documents/mpsc/2012_EO_Report_404891_7.pdf

VI. Energy Efficiency Options and Analysis (Optimal Energy Phase 2 Study)

Building upon the Michigan Electric and Natural Gas Energy Efficiency Study (Appendix B), Optimal Energy is currently conducting an analysis for Michigan to develop options for energy savings targets. The efficiency potential estimates from GDS Associates' draft potential study will be used to develop and present four concrete options for quantified annual energy and capacity targets and funding caps for years 2016-2020.

The first option will be based on the budget constrained scenario analyzed in the GDS potential study. These targets assume future Energy Optimization funding caps equivalent to 2% of a utility's retail revenue, which is the level currently established in Michigan via 2008 PA 295. Annual incremental energy savings will be based on first-year savings. Economic analysis (benefit/cost tests) for the budget constrained option will be based on the Utility Resource Cost test (URCT), e.g. target achievement must be at a URCT at or above 1.0 to be considered cost effective. This option will also present quantified 5 year annual energy and capacity targets and funding levels for 2016 through 2020 based on the budget constrained scenario. Annual incremental energy savings targets will be based on a lifecycle perspective.

The second option will be similar to the first, however, these targets assume future Energy Optimization funding caps are allowed to rise to a level sufficient to acquire the achievable energy efficiency potential satisfying a URCT screening with a rate of market adoption driven by a 50% rebate level. Funding levels will be presented in terms of dollars and percent of retail sales. Annual incremental energy savings will be based on first-year savings. Economic analysis for this option will be the same as the first option.

The third option will be similar, however, these targets assume future Energy Optimization funding caps are allowed to rise to a level sufficient to acquire the achievable energy efficiency potential satisfying a Total Resource Cost Test (TRC) screening with a rate of market adoption driven by a 50% rebate level. Funding levels will be presented in terms of dollars and percent of retail sales. Annual incremental energy savings will be based on first-year savings. Economic analysis (benefit/cost tests) will be based on the TRC, e.g. target achievement must be at a TRC at or above 1.0 to be considered cost effective. This option will also present quantified 5-year annual energy and capacity targets and funding levels based on the base achievable scenario. Spending levels presented will be the costs to achieve this potential, but measured on a lifecycle savings basis.

The fourth option will be based on the max achievable scenario analyzed in the GDS potential study. These targets assume future Energy Optimization funding caps are allowed to rise to a level sufficient to acquire the achievable energy efficiency potential satisfying a Total Resource Cost Test (TRC) screening with a rate of market adoption driven by a 100% rebate level. Funding levels will be presented in terms of dollars and percent of retail sales. Annual incremental energy savings will be based on first-year savings. Economic analysis for this option will be the same as the third option.

In addition to the four options outlined, Optimal Energy will also quantify options for demand targets that could be considered, and will explore expanded savings opportunities.

VII. Summary

Michigan has made significant progress since PA295 was enacted in 2008. The Michigan Public Service Commission and the Michigan Energy Office have taken the lead in ensuring that all aspects of PA295 are implemented to capture the total potential for energy efficiency in Michigan. Some of the noteworthy achievements, as articulated earlier in this report, are:

- Michigan's electricity and gas utilities are, on average, surpassing the standards set forth in PA 295.
- Natural gas utilities achieved 134% of their targets in 2011, while electric utilities achieved 116% of theirs; the combined average energy savings for providers met 125% of the targets created in PA 295.
- Evaluation data shows that Michigan's energy savings targets were met through 2011.
- For each dollar spent on the utility EO programs to date, customers will benefit from $3 in avoided energy costs, reaching an estimated total of $1.2 billion as a result of program operations in 2013 through 2015.
- Electric utilities have surpassed Michigan's EO standards each year since implementation.
- Estimated cost of conserved energy prices for Consumers Energy (2 cents per kWh for electricity, and $1.76 per MCF of natural gas) and DTE Energy (1 cent per kWh for its electric portfolio, and $1.5 per MCF for its gas programs).
- Based on average 2011 electricity generation costs and natural gas commodity costs data, Michigan's EO programs are cost-effective.
- Michigan has the potential to continue to achieve incremental cost-effective savings from energy efficiency.

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Appendices

Appendix A: An Overview of the Michigan Court of Appeals' Treatment of Michigan's Clean, Renewable, and Efficient Energy Act

Appendix B: *Michigan Electric and Natural Gas Energy Efficiency Potential Study*, Prepared for Michigan Public Service Commission by GDS Associates

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Appendix A

An Overview of the Michigan Court of Appeals' Treatment of Michigan's *Clean, Renewable, and Efficient Energy Act*

This background document provides an overview of the treatment that the Michigan Court of Appeals has afforded the 2008 *Clean, Renewable, and Efficient Energy Act* ("the Act") specifically with respect to utility-filed Energy Optimization ("EO") plans.[47]

Energy Optimization Plans Under the Act

Public Act 295, the *Clean, Renewable, and Efficient Energy Act* (MCL 460.1001 *et al*.), states (Sec. 1(2)):

> The purpose of this act is to promote the development of clean energy, renewable energy, and energy optimization through the implementation of a clean, renewable, and energy efficient standard that will cost-effectively do all of the following:
>
> (a) Diversify the resources used to reliably meet the energy needs of consumers in this state.
> (b) Provide greater energy security through the use of indigenous energy resources available within the state.
> (c) Encourage private investment in renewable energy and energy efficiency.
> (d) Provide improved air quality and other benefits to energy consumers and citizens of this state.

The Act (MCL 460.1005(e)) defines "energy optimization" as all of the following:

> (i) Energy efficiency.
>
> (ii) Load management, to the extent that the load management reduces overall energy usage.
>
> (iii) Energy conservation, but only to the extent that the decreases in the consumption of electricity produced by energy conservation are objectively measurable and attributable to an energy optimization plan.

Citing the statute, the Court of Appeals described Energy Optimization ("EO") Plans in the following manner:

> Broadly speaking, an energy optimization plan is designed to reduce the demand for energy and provide for load management, thereby reducing the future costs of

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[47] While Renewable Energy Plans were also at issue before the Court of Appeals, this document is limited to energy efficiency, which is within the scope of work on for this report.

> providing service to customers, "[i]n particular ... to delay the need for constructing new electric generating facilities and thereby protect consumers from incurring the costs of such construction." MCL 460.1071(2). See also MCL 460.1001(2).

In re Review of Consumers Energy Co. Renewable Energy Plan, 293 Mich. App. 254, 258-59, 820 N.W.2d 170, 173-74 (2011) appeal denied, 490 Mich. 1001, 807 N.W.2d 319 (2012). See also, In re Michigan Consol. Gas Co's Compliance With 2008 PA 286 & 295, 294 Mich. App. 119, 122, 818 N.W.2d 354, 357 (2011)

After the passage of the Act, the Michigan Public Service Commission ("PSC") issued temporary implementation orders and opened cases for all regulated electric and natural gas utilities.

Contested Issues

In two separate cases, the Association of Businesses Advocating Tariff Equity ("ABATE") appealed the PSC's acceptance of EO and Renewable Energy plans submitted by regulated utilities to the Michigan Court of Appeals. Those cases are:

(1) In re Review of Consumers Energy Co. Renewable Energy Plan, 293 Mich. App. 254, 820 N.W.2d 170 (2011), appeal denied, 490 Mich. 1001, 807 N.W.2d 319 (2012); and

(2) In re Michigan Consol. Gas Co's Compliance With 2008 PA 286 & 295, 294 Mich. App. 119, 122, 818 N.W.2d 354, 357 (2011).

In both appeals, ABATE alleged that the Michigan PSC misinterpreted the Act and argued that the Act:

(1) Does not subject natural gas transportation-only customers to EO plan surcharges of gas transportation providers; and

(2) Applies an exemption from surcharges for natural gas EO plans for electric customers who file self-directed EO plans; and

In both cases, the court rejected ABATE's arguments and affirmed the PSC's interpretation of the Act.

Standard of Review

The court first explained that the standard of review applied to PSC decisions is narrow and well-defined and that "all rates, fares, charges, classification and joint rates, regulations, practices, and services prescribed by the PSC are presumed, prima facie, to be lawful and reasonable." In re Review of Consumers Energy Co. Renewable Energy Plan, 293 Mich. App. 254, 267, 820 N.W.2d 170, 178 (2011) appeal denied, 490 Mich. 1001, 807 N.W.2d 319 (2012) (citing to *Michigan Consolidated Gas Co. v. Public Service Comm.*, 389 Mich. 624, 635–636, 209 N.W.2d 210 (1973).

With respect to review of PSC factual determinations, judicial review of administrative agency decisions must "not invade the province of exclusive administrative fact-finding by displacing an agency's choice between two reasonably differing views." *Employment Relations Comm. v. Detroit Symphony Orchestra*, 393 Mich. 116, 124 [223 N.W.2d 283] (1974)

Finally, with respect to statutory interpretation, the court stated that its primary goal is to "give effect to the intent of the Legislature…If the statutory language is unambiguous, the Legislature is presumed to have intended the meaning expressed in the statute." *Briggs Tax Serv., LLC v. Detroit Pub. Schools*, 485 Mich. 69, 76, 780 N.W.2d 753 (2010).

Substantive Determinations

1. Whether [natural gas] transportation-only customers should be subjected to EO plan surcharges

As to ABATE's first claim, the court held that the PSC correctly found that gas transportation customers are "natural gas customers" under the statute and therefore, a portion of the natural gas providers' EO plan costs could be charged back to the providers' gas transportation customers. In re Review of Consumers Energy, 293 Mich. App. 254, 269, 820 N.W.2d 170, 179 (2011)

The court relied on its analysis in an earlier unpublished opinion in which it reviewed the PSC's temporary implementation order of the Act. In that case the court agreed with the PSC that

> the Legislature intended to include natural gas transportation customers in the providers' energy optimization plans (either administered internally or run by the PSC's program administrator) and to count the transportation revenues for purposes of determining the size of the plans and the ability to implement the true-up mechanism. In re Temp. Order to Implement 2008 Pa 295, 290640, 2010 WL 4026100 (Mich. Ct. App. Oct. 14, 2010).

In reviewing the testimony in the Michigan Consolidated Gas Co. case, the court stated that it appeared as if the utility "planned that gas transportation customers would benefit from its energy optimization plan and take part in its incentives programs, even though the transportation customers receive gas commodity from a different source." In re Michigan Consol. Gas Co 294 Mich. App. 133, 818 N.W.2d 363.

2. Whether the exemption for self-directed plans applies to electric and gas providers

As to ABATE's second concern - whether an eligible electric customer, who files a self-directed energy optimization plan with its electric provider is exempt from the surcharges of only its electric provider or from both its gas and electric providers – the court again relied upon its analysis in its opinion reviewing the PSC's implementation order and agreed with the PSC's interpretation of the Act.

On this issue the PSC found that it was highly unlikely that the Legislature would have, in a section of the Act dealing explicitly with electric customers who file self-directed electric energy optimization plans, provided a loophole by which an electric sales customer who elects to do a self-directed electric program can avoid not only the electric surcharge, but also any gas surcharges assessed to gas sales customers. In re Temp. Order, 290640, 2010 WL 4026100.

> The court agreed with the PSC that the purpose of the statutory provision is to provide alternative forms of provider-based energy optimization plans, and provide coverage for the cost of funding the plans. A self-directed energy plan obviates the need for the customer to participate in its electric provider's optimization plan, and effectively replaces it. In re Michigan Consol. Gas Co's Compliance With 2008 PA 286 & 295, 294 Mich. App. 119, 135, 818 N.W.2d 354, 364 (2011)

Thus, the Court of Appeals denied ABATE's interpretation of the Act's exemption provision.

Conclusion

The court determined that the PSC correctly interpreted the Act when it held that natural gas transportation-only customers are subject to EO plan surcharges; and that electric customers who file self-directed plans are exempt only from electric surcharges.

Appendix B: Michigan Electric and Natural Gas Energy Efficiency Potential Study (Draft)

Draft Prepared by GDS Associates

Michigan Electric and Natural Gas Energy Efficiency Potential Study

Draft Report

Prepared for:

Michigan Public Service Commission

Consumers Energy

DTE Energy

October 9, 2013

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1 EXECUTIVE SUMMARY

BACKGROUND

The Michigan Public Service Commission, DTE Energy and Consumers Energy worked together to complete this 2013 study of energy efficiency potential in the state of Michigan. This energy efficiency potential study provides a roadmap for policy makers and identifies the energy efficiency measures having the greatest potential savings and the measures that are the most cost effective. In addition to technical and economic potential estimates, the development of achievable potential estimates for a range of feasible energy efficiency measures is useful for program planning and modification purposes. Unlike achievable potential estimates, technical and economic potential estimates do not include customer acceptance considerations for energy efficiency measures, which are often among the most important factors when estimating the likely customer response to new programs. For this study, GDS Associates, the consulting firm retained to conduct this study, produced the following estimates of energy efficiency potential:

- Technical potential
- Economic potential
- Achievable potential

Definitions of the types of energy efficiency potential are provided below.

1. **TECHNICAL POTENTIAL** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.
2. **ECONOMIC POTENTIAL** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.
3. **ACHIEVABLE POTENTIAL** is the amount of energy use that efficiency can realistically be expected to displace assuming different market penetration scenarios for cost effective energy efficiency measures. An aggressive scenario, for example, could, provide program participants with payments for the entire incremental cost of more energy efficient equipment). This is often referred to as "maximum achievable potential". Achievable potential takes into account real-world barriers to convincing end-users to adopt cost effective energy efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[1] Achievable savings potential savings is a subset of economic potential.

The purpose of this energy efficiency potential study is to provide a foundation for the continuation of utility-administered energy efficiency programs in Michigan and to determine the remaining opportunities for cost effective electricity and natural gas energy efficiency savings for the state of

[1] These definitions are from the November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies"

Michigan. This detailed report presents results of the technical, economic, and achievable potential for electric and natural gas efficiency measures in Michigan for two time periods:

- The five-year period from January 1, 2014 through December 31, 2018
- The ten-year period from January 1, 2014 through December 31, 2023

All results were developed using customized residential, commercial and industrial sector-level potential assessment analytic models and Michigan-specific cost effectiveness criteria including the most recent Michigan-specific avoided cost projections for electricity and natural gas. To help inform these energy efficiency potential models, up-to-date energy efficiency measure data were primarily obtained from the following recent studies and reports:

1. Michigan Energy Measures Database (MEMD)
2. Energy efficiency baseline studies conducted by DTE Energy and Consumers Energy
3. 2009 EIA Residential Energy Consumption Survey (RECS)
4. 2007 American Housing Survey (AHS)
5. 2003 EIA Commercial Building Energy Consumption Survey (CBECS)

The above data sources provided valuable information regarding the current saturation, costs, savings and useful lives of electric and natural gas energy efficiency measures considered in this study.

The results of this study provide detailed information on energy efficiency measures that are the most cost effective and have the greatest potential electric and natural gas savings for the State of Michigan. The data used for this report were the best available at the time this analysis was developed. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become outdated.

COST EFFECTIVENESS FINDINGS

This study examines economic potential scenarios using the Total Resource Cost (TRC) test and the Utility Cost Test (UCT). This energy efficiency potential study concludes that significant cost effective electric and natural gas energy efficiency potential remains in in Michigan. Tables 1-1 and 1-2 show the preliminary present value benefits, costs and benefit-cost ratios for the Achievable Potential scenarios examined in this study.

Table 1-1: Benefit-Cost Ratios for Achievable Potential Scenarios For 2014 to 2018 Time Period

Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	Benefit/Cost Ratio
Achievable UCT	$12,882,773,443	$4,483,103,484	2.87
Achievable TRC	$13,066,208,938	$3,993,036,655	3.27
Constrained UCT	$3,902,083,465	$1,378,148,311	2.83

Table 1-2: Benefit-Cost Ratios for Achievable Potential Scenarios For 2014 to 2023 Time Period

Achievable Potential Scenarios	NPV $ Benefits	NPV $ Costs	Benefit/Cost Ratio
Achievable UCT	$22,890,937,898	$7,524,246,046	3.04
Achievable TRC	$22,928,797,332	$6,597,930,173	3.48
Constrained UCT	$7,314,471,223	$2,405,262,802	3.04

In addition, GDS did calculate TRC and UCT benefit/cost ratios for each individual energy efficiency measure considered in this study. Only measures that had a benefit/cost ratio greater than or equal to 1.0 were retained in the economic and achievable potential savings estimates. It is important to note that energy efficiency measures for low income households do not need to be cost effective in Michigan. For purposes of this draft report, GDS has excluded non cost effective measures from estimates of economic and achievable potential energy efficiency savings.

STUDY SCOPE

The study examines the potential to reduce electric consumption and peak demand and natural gas consumption through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in Michigan. This study assesses electric and natural gas energy efficiency potential in Michigan over ten years, from 2014 through 2023.

The study had the following main objectives:

- Evaluate the electric and natural gas energy efficiency technical, economic and achievable potential savings in the State of Michigan;
- Calculate the economic and achievable potential energy efficiency savings based upon cost effectiveness screening with both the TRC and UCT benefit/cost ratios.

As noted above, the scope of this study distinguishes among three types of energy efficiency potential; (1) technical, (2) economic, and (3) achievable potential. The definitions used in this study for energy efficiency potential estimates were obtained directly from a 2007 National Action Plan for Energy Efficiency (NAPEE) report. Figure 1-1 below provides a graphical representation of the relationship of the various definitions of energy efficiency potential.

Figure 1-1: Types of Energy Efficiency Potential[2]

Not Technically Feasable	Technical Potential		
Not Technically Feasable	Not Cost Effective	Economic Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential

Limitations to the scope of study: As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions and data sources, including the following:

- Energy efficiency measure lives, measure savings and measure costs
- The discount rate for determining the net present value of future savings
- Projected penetration rates for energy efficiency measures
- Projections of Michigan specific electric and natural gas avoided costs
- Future changes to current energy efficiency codes and standards for buildings and equipment

While the GDS Team has sought to use the best and most current available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different

[2] Reproduced from “Guide to Resource Planning with Energy Efficiency” November 2007. US EPA. Figure 2-1.

results. Furthermore, while the lists of energy efficiency measures examined in this study represent most commercially available measures, these measure lists are not exhaustive.

With respect to non-energy benefits of energy efficiency programs, GDS did include an adder of $9.25 per ton of carbon for reduced emissions of CO2. This is the expected value for reduced carbon emissions based upon equal weighting of a scenario with no carbon taxes and a scenario where a carbon tax of $18.50 per ton is implemented in the future.

Finally there was no attempt to place a dollar value on some difficult to quantify benefits arising from installation of some measures, such as increased comfort or increased safety, which may in turn support some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

SUMMARY OF RESULTS

This study examined 1440 energy efficiency measures and 811 natural gas measures in the residential, commercial and industrial sectors combined.

Tables 1-3 and 1-4 below show that cost effective electric energy efficiency resources can play a significantly expanded role in Michigan's energy resource mix over the next five and ten years. For the State of Michigan overall, the achievable potential for electricity savings based on the UCT in 2023 is 16.1% of forecast kWh sales for 2023. For the State overall, the achievable potential for natural gas savings based on the UCT in 2023 is 14.7% of forecast MMBtu sales for 2023. Tables 1-3 and 1-4 present the energy efficiency savings potential for all scenarios over a period of 5 and 10 years, respectively.

Table 1-3: Summary of Technical, Economic and Achievable Electric Energy Savings for 2018

	Technical Potential	Economic Potential (UCT)	Economic Potential (TRC)	Achievable Potential (UCT)	Achievable Potential (TRC)	Constrained Achievable (UCT)
Electric Savings (MWh)						
Savings % - Residential	46.5%	42.5%	39.6%	11.1%	10.5%	5.2%
Savings % - Commercial	46.8%	43.0%	36.1%	11.5%	10.0%	2.9%
Savings % - Industrial	22.5%	20.9%	18.5%	5.9%	5.2%	1.4%
Savings % - Total	**38.9%**	**35.7%**	**31.6%**	**9.5%**	**8.6%**	**3.2%**
Savings MWh - Residential	15,729,887	14,356,678	13,387,948	3,737,232	3,559,727	1,752,880
Savings MWh - Commercial	17,876,511	16,427,488	13,785,317	4,387,436	3,824,632	1,111,833
Savings MWh - Industrial	7,640,370	7,116,215	6,302,402	1,998,256	1,763,195	484,455
Savings MWh - Total	**41,246,768**	**37,900,381**	**33,475,668**	**10,122,924**	**9,147,554**	**3,349,168**
Electric Demand (MW)						
Savings % - Residential	44.8%	40.9%	39.6%	8.5%	8.2%	4.0%
Savings % - Commercial	57.6%	50.9%	43.7%	13.6%	12.1%	5.8%
Savings % - Industrial	32.4%	31.8%	25.0%	9.5%	6.9%	2.3%
Savings % - Total	**48.1%**	**43.6%**	**38.8%**	**10.8%**	**9.6%**	**4.5%**
Savings MW - Residential	4,482	4,099	3,965	846	821	398
Savings MW - Commercial	6,127	5,414	4,642	1,446	1,288	621
Savings MW - Industrial	1,430	1,401	1104	417	305	101
Savings MW - Total	**12,039**	**10,914**	**9,711**	**2,709**	**2,414**	**1,120**
Natural Gas Savings (MMBtu)						
Savings % - Residential	45.1%	34.5%	15.5%	8.7%	5.8%	4.1%
Savings % - Commercial	33.0%	28.3%	21.1%	6.9%	5.2%	1.4%
Savings % - Industrial	25.5%	18.9%	17.8%	7.0%	6.6%	1.2%
Savings % - Total	**36.8%**	**28.8%**	**17.6%**	**7.8%**	**5.8%**	**2.6%**

	Technical Potential	Economic Potential (UCT)	Economic Potential (TRC)	Achievable Potential (UCT)	Achievable Potential (TRC)	Constrained Achievable (UCT)
Savings MMBtu - Residential	134,441,426	102,805,470	46,104,387	25,789,337	17,129,691	12,160,708
Savings MMBtu - Commercial	56,265,693	48,131,792	36,004,934	11,736,125	8,910,018	2402050
Savings MMBtu - Industrial	41,436,733	30,680,739	28,922,334	11,365,156	10,720,661	1,906,463
Savings MMBtu - Total	**232,143,852**	**181,618,001**	**111,031,654**	**48,890,618**	**36,760,370**	**16,469,221**

Table 1-4: Summary of Technical, Economic and Achievable Electric Energy Savings for 2023

	Technical Potential	Economic Potential (UCT)	Economic Potential (TRC)	Achievable Potential (UCT)	Achievable Potential (TRC)	Constrained Achievable (UCT)
Electric Savings (MWh)						
Savings % - Residential	46.7%	42.6%	39.7%	17.9%	16.8%	8.3%
Savings % - Commercial	46.3%	42.5%	35.7%	19.2%	16.7%	5.1%
Savings % - Industrial	22.0%	20.5%	18.1%	11.1%	9.7%	3.0%
Savings % - Total	**38.6%**	**35.5%**	**31.3%**	**16.1%**	**14.5%**	**5.5%**
Savings MWh - Residential	16,104,075	14,691,791	13,688,112	6,160,705	5,811,199	2,851,602
Savings MWh - Commercial	17,953,973	16,501,229	13,857,354	7,436,332	6,482,426	1,985,411
Savings MWh - Industrial	7,640,370	7,116,215	6,302,402	3,849,419	3,379,759	1,043,685
Savings MWh - Total	**41,698,418**	**38,309,235**	**33,847,868**	**17,446,456**	**15,673,384**	**5,880,698**
Electric Demand (MW)						
Savings % - Residential	44.8%	41.0%	39.7%	14.0%	13.7%	6.5%
Savings % - Commercial	57.0%	50.4%	43.2%	22.7%	20.2%	6.4%
Savings % - Industrial	31.7%	31.1%	24.5%	18.4%	12.5%	5.1%
Savings % - Total	**47.7%**	**43.2%**	**38.5%**	**18.5%**	**16.2%**	**6.2%**
Savings MW - Residential	4,582	4,191	4,056	1,434	1,400	665
Savings MW - Commercial	6,153	5,438	4,666	2,451	2,183	688
Savings MW - Industrial	1,430	1,401	1104	829	562	228
Savings MW - Total	**12,165**	**11,030**	**9,826**	**4,714**	**4,145**	**1,581**
Natural Gas Savings (MMBtu)						
Savings % - Residential	49.3%	37.7%	17.0%	17.1%	10.5%	8.0%
Savings % - Commercial	33.3%	28.5%	21.3%	13.9%	10.5%	2.9%
Savings % - Industrial	27.1%	20.0%	18.9%	11.1%	10.6%	2.4%
Savings % - Total	**39.2%**	**30.7%**	**18.7%**	**14.7%**	**10.5%**	**5.1%**
Savings MMBtu - Residential	138,360,584	105,993,453	47,635,614	48,112,745	29,576,545	22,407,275
Savings MMBtu - Commercial	56,463,739	48,308,309	36,098,275	23,472,249	17,820,037	4942660
Savings MMBtu - Industrial	41,436,733	30,680,739	28,922,334	17,022,073	16,218,312	3,685,220
Savings MMBtu - Total	**236,261,056**	**184,982,501**	**112,656,223**	**88,607,067**	**63,614,894**	**31,035,155**

The five-year and ten-year budgets and acquisition costs for the achievable potential scenarios for electric and natural gas energy efficiency savings are shown in Table 1-7 and 1-8.

Table 1-7: Achievable Potential Scenarios; Budgets and Acquisition Costs Per Unit of Energy Saved – Electric Savings

ALL SECTORS COMBINED	5 - Year EE Budget	10-Year EE Budget	Acquisition Cost Per First Year kWh Saved - 5 years	Acquisition Cost Per First Year kWh Saved - 10 years
Achievable UCT	$3,245,488,911	$6,237,409,397	$0.26	$0.24
Achievable TRC	$1,951,914,432	$3,689,449,357	$0.19	$0.17
Constrained UCT	$891,927,230	$1,840,260,238	$0.24	$0.22

Table 1-8: Achievable Potential Scenarios; Budgets and Acquisition Costs Per Unit of Energy Saved – Natural Gas Savings

ALL SECTORS COMBINED	5 - Year EE Budget	10-Year EE Budget	Acquisition Cost Per First Year MMBtu Saved - 5 years	Acquisition Cost Per First Year MMBtu Saved - 10 years
Achievable UCT	$1,475,753,314	$2,906,852,985	$27.83	$27.47
Achievable TRC	$803,489,739	$1,534,397,133	$19.27	$18.59
Constrained UCT	$539,888,930	$1,092,223,149	$29.38	$28.51

ENERGY EFFICIENCY POTENTIAL SAVINGS DETAIL

Note that Sections 6, 7 and 8 of this report include additional detail about the electric and natural gas energy efficiency savings potential in Michigan by 2023.

REPORT ORGANIZATION

The remainder of this report is organized as follows:

Section 2: Glossary of Terms defines key terminology used in the report.

Section 3: Introduction highlights the purpose of this study and the importance of energy efficiency.

Section 4: Characterization of Electric and Natural Gas Energy Consumption in Michigan provides an overview of the economic/demographic characteristics of Michigan and a brief discussion of the historical and forecasted electric and natural gas energy sales by sector as well as electric peak demand.

Section 5: Potential Study Methodology details the approach used to develop the estimates of technical, economic and achievable potential savings for electric and natural gas energy efficiency savings.

Section 6: Residential Electric and Natural Gas Energy Efficiency Potential Estimates (2013-2022) provides a breakdown of the technical, economic, and achievable potential in the residential sector.

Section 7: Commercial Sector Electric and Natural Gas Energy Efficiency Potential Estimates (2014-2023) provides a breakdown of the technical, economic, and achievable savings potential in the commercial sector.

Section 8: Industrial Sector Electric and Natural Gas Energy Efficiency Potential Estimates (2014-2023) provides a breakdown of the technical, economic, and achievable savings potential in the industrial sector.

Section 9: Summary of Results presents the final discussion regarding potential for energy efficiency savings through 2023 in Michigan.

2 GLOSSARY OF TERMS[3]

The following list defines many of the key energy efficiency terms used throughout this energy efficiency potential study.

Achievable Potential: The November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies" defines achievable potential as the amount of energy use that energy efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (*e.g.*, providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.

Applicability Factor: The fraction of the applicable housing units or businesses that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket in a home).

Avoided Costs: For purposes of this report, electric avoided costs are defined as the generation, transmission and distribution costs that can be avoided in the future if the consumption of electricity or natural gas can be reduced with energy efficiency or demand response programs. For a natural gas utility, the avoided costs include the cost of the natural gas commodity and any other natural gas infrastructure costs that can be reduced with energy efficiency programs.

Base Achievable Potential: For purposes of this study, an achievable potential scenario which assumes incentives are set to 50% of the incremental or full measure cost.

Base Case Equipment End-Use Intensity: The electricity or natural gas used per customer per year by each base-case technology in each market segment. This is the consumption of the electric or natural gas energy using equipment that the efficient technology replaces or affects. For example, if the efficient measure is a high efficiency light bulb (CFL), the base end-use intensity would be the annual kWh use per bulb per household associated with an incandescent or halogen light bulb that provides equivalent lumens to the CFL.

Base Case Factor: The fraction of the market that is applicable for the efficient technology in a given market segment. For example, for the residential electric clothes washer measure, this would be the fraction of all residential customers that have an electric clothes washer in their household.

Capital Recovery Rate (CRR): The return of invested capital expressed as an annual rate; often applied in a physical sense to wasting assets with a finite economic life.[4]

Coincidence Factor: The fraction of connected load expected to be "on" and using electricity coincident with the electric system peak period.

Constrained Achievable: An achievable potential scenario which assumes a lower level of incentives or lower annual program budgets than in the base case scenario.

[3] Potential definitions taken from National Action Plan for Energy Efficiency (2007). "Guide for Conducting Energy Efficiency Potential Studies." Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc.

[4] Accuval. http://www.accuval.net/insights/glossary/

Cost-Effectiveness: A measure of the relevant economic effects resulting from the implementation of an energy efficiency measure or program. If the benefits are greater than the costs, the measure is said to be cost-effective.

Cumulative Annual: Refers to the overall annual savings occurring in a given year from both new participants and annual savings continuing to result from past participation with energy efficiency measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as some energy efficiency measures have relatively short lives and, as a result, their savings drop off over time.

Commercial Sector: Comprised of non-manufacturing premises typically used to sell a product or provide a service, where electricity is consumed primarily for lighting, space cooling and heating, office equipment, refrigeration and other end uses. Business types are included in Section 5 – Methodology.

Demand Response: Refers to electric demand resources involving dynamic hourly load response to market conditions, such as curtailment or load control programs.

Early Replacement: Refers to an energy efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units.

Economic Potential: The November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies" refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources as economic potential. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, evaluation) that would be necessary to capture them.

End-Use: A category of equipment or service that consumes energy (*e.g.*, lighting, refrigeration, heating, process heat, cooling).

Energy Efficiency: Using less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. Sometimes "conservation" is used as a synonym, but that term is usually taken to mean using less of a resource even if this results in a lower service level (*e.g.*, setting a thermostat lower or reducing lighting levels).

Energy Use Intensity (EUI): A unit of measurement that describes a building's energy use. EUI represents the energy consumed by a building relative to its size.[5]

Free Driver: Individuals or businesses that adopt an energy efficient product or service because of an energy efficiency program, but are difficult to identify either because they do not receive an incentive or are not aware of the program.

Free Rider: Participants in an energy efficiency program who would have adopted an energy efficiency technology or improvement in the absence of a program or financial incentive.

[5] See http://www.energystar.gov/index.cfm?fuseaction=buildingcontest.eui

Gross Savings: Gross energy (or demand) savings are the change in energy consumption or demand that results directly from program-promoted actions (e.g., installing energy-efficient lighting) taken by program participants regardless of the extent or nature of program influence on their actions.

Incentive Costs: A rebate or some form of payment used to encourage people to implement a given demand-side management (DSM) technology.

Incremental: Savings or costs in a given year associated only with new installations of energy efficiency or demand response measures happening in that specific year.

Industrial Sector: Comprised of manufacturing premises typically used for producing and processing goods, where electricity is consumed primarily for operating motors, process cooling and heating, and space heating, ventilation, and air conditioning (HVAC). Business types are included in section 5 – Methodology.

Maximum (or Max) Achievable: An achievable potential scenario which assumes incentives for program participants are equal to 100% of measure incremental or full costs.

Measure: Any action taken to increase energy efficiency, whether through changes in equipment, changes to a building shell, implementation of control strategies, or changes in consumer behavior. Examples are higher-efficiency central air conditioners, occupancy sensor control of lighting, and retro-commissioning. In some cases, bundles of technologies or practices may be modeled as single measures. For example, an ENERGY STAR® ™ home package may be treated as a single measure.

MMBtu: A measure of power, used in this report to refer to consumption and savings associated with natural gas consuming equipment. One British thermal unit (symbol Btu or sometimes BTU) is a traditional unit of energy equal to about 1055 joules. It is the amount of energy needed to heat one pound of water by one degree Fahrenheit. MMBtu is defined as one million BTUs.

MW: A unit of electrical output, equal to one million watts or one thousand kilowatts. It is typically used to refer to the output of a power plant.

MWh: One thousand kilowatt-hours, or one million watt-hours. One MWh is equal to the use of 1,000,000 watts of power in one hour.

Net-to-Gross Ratio: A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts

Net Savings: Net energy or demand savings refer to the portion of gross savings that is attributable to the program. This involves separating out the impacts that are a result of other influences, such as consumer self-motivation. Given the range of influences on consumers' energy consumption, attributing changes to one cause (i.e., a particular program) or another can be quite complex.

Non Incentive Cost: Costs incurred by the utility that do not include incentives paid to the customer (i.e.: program administrative costs, program marketing costs, data tracking and reporting, program evaluation, etc.)

Nonparticipant Spillover: Savings from efficiency projects implemented by those who did not directly participate in a program, but which nonetheless occurred due to the influence of the program.

Participant Cost: The cost to the participant to participate in an energy efficiency program.

Participant Spillover: Additional energy efficiency actions taken by program participants as a result of program influence, but actions that go beyond those directly subsidized or required by the program.[6]

Portfolio: Either a collection of similar programs addressing the same market, technology, or mechanisms; or the set of all programs conducted by one energy efficiency organization or utility.

Program: A mechanism for encouraging energy efficiency that may be funded by a variety of sources and pursued by a wide range of approaches (typically includes multiple energy efficiency measures).

Program Potential: The November 2007 National Action Plan for Energy Efficiency 'Guide for Conducting Energy Efficiency Potential Studies" refers to the efficiency potential possible given specific program funding levels and designs as program potential. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding. Program potential studies can consider scenarios ranging from a single program to a full portfolio of programs. A typical potential study may report a range of results based on different program funding levels.

Remaining Factor: The fraction of applicable units that have not yet been converted to the electric or natural gas energy efficiency measure; that is, one minus the fraction of units that already have the energy efficiency measure installed.

Replace-on-burnout: An energy efficiency measure is not implemented until the existing technology it is replacing fails or burns out. An example would be an energy efficient water heater being purchased after the failure of the existing water heater at the end of its useful life.

Resource Acquisition Costs: The cost of energy savings associated with energy efficiency programs, generally expressed in costs per first year or per lifetime MWH saved ($/MWh), kWh ($/kWh), or MMBtu ($/MMBtu) in this report.

Retrofit: Refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units (also called "early retirement") or the installation of additional controls, equipment, or materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, low flow devices, lighting occupancy controls, economizer ventilation systems).

Savings Factor: The percentage reduction in electricity or natural gas consumption resulting from application of the efficient technology. The savings factor is used in the formulas to calculate energy efficiency potential.

Societal Cost Test: Measures the net benefits of the energy efficiency program for a region or service area as a whole. Costs included in the SCT are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. The SCT may also include non-energy costs, such as reduced customer comfort levels. The benefits included are the avoided costs of energy and capacity, plus environmental and other non-energy benefits that are not currently valued by the market.

Technical Potential: The theoretical maximum amount of energy use that could be displaced by energy efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the energy efficiency measures. It is often estimated as a "snapshot" in time assuming

[6] The definitions of participant and nonparticipant spillover were obtained from the National Action Plan for Energy Efficiency Report titled "Model Energy Efficiency Program Impact Evaluation Guide", November 2007, page ES-4.

immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.

Total Resource Cost Test: The TRC measures the net benefits of the energy efficiency program for a region or service area as a whole from the combined perspective of the utility and program participants. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. Costs include all costs for the utility and the participants. The benefits included are the avoided costs of energy and capacity plus any quantifiable non-energy benefits (such as reduced emissions of carbon dioxide).

Utility Cost Test: The UCT measures the net benefits of the energy efficiency program for a region or service area as a whole from the utility's perspective. Costs included in the UCT are the utility's costs to design, implement and evaluate a program. The benefits included are the avoided costs of energy and capacity.

3 INTRODUCTION

This report assesses the potential for electric and natural gas energy efficiency programs to assist Michigan in meeting future energy service needs. This section of the report provides the following information:

- Defines the term "energy efficiency";
- Describes the general benefits of energy efficiency programs;
- Provides results of similar energy efficiency potential studies conducted in other states; and,
- Describes contents of the Sections of this report.

The purpose of this energy efficiency potential study is to provide a detailed assessment of the technical, economic and achievable potential for electric and natural gas energy efficiency Michigan. This study has examined a full array of energy efficiency technologies and energy efficient building practices that are technically achievable. The results of this study can be used to develop energy efficiency goals for Michigan in the short and long-term. The strategies that will be developed based on this potential study will guide direction and scope of utility administered energy efficiency programs in reducing electric and natural gas energy consumption in Michigan.

3.1 INTRODUCTION TO ENERGY EFFICIENCY

Efficient energy use, often referred to as energy efficiency, is using less energy to provide the same level of energy service. An example would be insulating a home or business to use less heating and cooling energy to achieve the same inside temperature. Another example would be installing fluorescent lighting in place of less efficient halogen or incandescent lights to attain the same level of illumination. Energy efficiency can be achieved through more efficient technologies and/or processes as well as through changes in individual behavior.

3.1.1 General Benefits of Energy Efficiency

There are a number of benefits that accrue to the State of Michigan due to electric and natural gas energy efficiency programs. These benefits include avoided cost savings, non-electric benefits such as water and fossil fuel savings, environmental benefits, economic stimulus, job creation, risk reduction, and energy security.

Avoided electric energy and capacity costs are based upon the costs an electric utility would incur to construct and operate new electric power plants or to purchase power from another source. These avoided costs of electricity include both fixed and variable costs that can be directly avoided through a reduction in electricity usage. The energy component includes the costs associated with the production of electricity, while the capacity component includes costs associated with the capability to deliver electric energy during peak periods. Capacity costs consist primarily of the costs associated with building peaking generation facilities. The forecasts of electric energy and capacity avoided costs and natural gas avoided costs used in this study were provided to GDS by the Michigan Public Service Commission. Avoided costs for natural gas include the avoided costs of the natural gas commodity and any other savings on the natural gas distribution system for operations and maintenance expenses or natural gas infrastructure expenditures.

At the consumer level, energy efficient products often cost more than their standard efficiency counterparts, but this additional cost is balanced by lower energy consumption and lower energy bills. Over time, the money saved from energy efficient products will pay consumers back for their initial investment as well as save them money on their electric and natural gas bills. Although some energy efficient technologies are complex and expensive, such as installing new high efficiency windows or a high efficiency boiler, many are simple and inexpensive. Installing compact fluorescent lighting or low-flow water devices, for example, can be done by most individuals.

Although the reduction in electric and natural gas costs is the primary benefit to be gained from investments in energy efficiency, the electric and natural gas utilities in Michigan, their consumers, and society as a whole can also benefit in other ways. Many electric efficiency measures also deliver non-energy benefits. For example, low-flow water devices and efficient clothes washers also reduce water consumption.[7] Similarly, weatherization measures that improve the building shell not only save on air conditioning costs in the summer, but also can save the customer money on space heating fuels, such as natural gas or propane. Reducing electricity consumption also reduces harmful emissions from power plants, such as SO_X, NO_X, CO_2 and particulates into the environment.[8]

Energy efficiency programs create both direct and indirect jobs. The manufacture and installation of energy efficiency products involves the manufacturing sector as well as research and development, service, and installation jobs. These are skilled positions that are not easily outsourced to other states and countries. The creation of indirect jobs is more difficult to quantify, but result from households and businesses experiencing increased discretionary income from reduced energy bills. These savings produce multiplier effects, such as increased investment in other goods and services driving job creation in other markets.

Energy efficiency reduces risks associated with fuel price volatility, unanticipated capital cost increases, environmental regulations, supply shortages, and energy security. Aggressive energy efficiency programs can help eliminate or postpone the risk associated with committing to large investments for generation facilities a decade or more before they are needed. Energy efficiency is also not subject to the same supply and transportation constraints that impact fossil fuels. Finally, energy efficiency reduces competition between states and utilities for fuels, and reduces dependence on fuels imported from other states or countries to support electricity production. Energy efficiency can help meet future demand increases and reduce dependence on out-of-state or overseas resources.

3.2 THE MICHIGAN CONTEXT

3.2.1 Continuing Customer Growth

The annual kWh sales and electric system peak load for the State of Michigan is projected to increase over the next decade. From 2002 to 2011, the number of residential electric utility customers in Michigan remained fairly constant, growing at a rate of approximately 0.1% annually.[9] The electric load forecasts for Michigan developed by GDS indicates that the number of electric consumers in Michigan will continue to increase at a rate of 0.34% per year from 2014 through 2023 (the timeframe for this study) creating further growth in system electricity sales and peak demand. Natural gas sales, however, are projected to decrease slightly at a rate of -0.88% per year from 2014 to 2023. This report assesses the potential for electric and natural gas energy efficiency programs to assist the State of Michigan in meeting future electric and natural gas energy service needs.

[7] The ENERGY STAR web site (www.energystar.gov) states that "ENERGY STAR qualified clothes washers use about 37% less energy and use over 50% less water than regular washers".

[8] The 2012 ENERGY STAR Annual Report states that 18,000 organizations across the US partnered with the US Environmental Protection Administration to improve energy efficiency while also realizing significant environmental and financial benefits. These EPA partners and individuals helped achieve energy savings while preventing more than 1.8 billion metric tons of GHG and saving over $230 billion on utility bills. Consumers and businesses that also partnered with ENERGY STAR also reduced their utility bills by $24 billion. With the help of ENERGY STAR, Americans were able to prevent 242 million metric tons of GHG during 2012, providing over $5.8 billion in benefits to society.

[9] This is the compound average annual growth rate for residential electric customers in Michigan.

3.2.2 Energy Efficiency Activity

Making homes and buildings more energy efficient is seen as a key strategy for addressing energy security, reducing reliance on fossil fuels from other countries, assisting consumers to lower energy bills, and addressing concerns about climate change. Faced with rapidly increasing energy prices, constraints in energy supply and demand, and energy reliability concerns, states are turning to energy efficiency as the most reliable, cost-effective, and quickest resource to deploy.[10]

3.2.3 Recent Energy Efficiency Potential Studies

Table 3-1, below, provides the results from a GDS review of recent energy efficiency potential studies conducted throughout the United States. It is useful to examine the results of these studies to understand if these studies are similar to this latest study for Michigan.

Table 3-1: Results of Recent Energy Efficiency Potential Studies in the US

STATE	STUDY YEAR	AUTHOR	STUDY PERIOD	# OF YEARS	ACHIEVABLE POTENTIAL
Missouri	2011	ACEEE	2011-2020	10	6.4%
District of Columbia	2013	GDS	2014-2023	10	28%
New Hampshire	2009	GDS	2009-2018	10	20.5%
Rhode Island	2008	KEMA	2009-2018	10	9.0%
Vermont	2011	GDS/Cadmus	2011-2018	10	9.0%
New York	2010	Global Energy Partners	2011-2018	8	9.0%
USA	2009	McKinsey & Company	2011-2020	10	23.0%
Pennsylvania	2012	Statewide Evaluator	2013-2023	10	17.3%

A 2012 report by the American Council for an Energy Efficient Economy (ACEEE) offers information regarding the current savings and spending related to energy efficiency by state.[11] Based on self-reported data, the eleven states annually spent more than 2% of electric sales revenue on electric energy efficiency programs in 2011. GDS has also examined actual energy efficiency savings data for 2010 and 2011 from the US Energy Information Administration (EIA) on the top twenty energy efficiency electric utilities. These top twenty utilities saved over 2% of annual kWh sales in 2010 with their energy efficiency programs, and 3.8% of annual kWh sales in 2011. These percentage savings are attributable to energy efficiency measures installed in a one-year time frame and demonstrate what can be accomplished with full-scale and aggressive implementation of programs.

3.3 COST-EFFECTIVENESS FINDINGS

The Total Resource Cost Test and Utility Cost Test calculations in this study follow the prescribed methodology detailed in the latest version of the California Standard Practice Manual (CA SPM). The California Standard Practice Manual establishes standard procedures for cost-effectiveness evaluations for utility-sponsored or public benefits programs and is generally considered to be an authoritative source for defining cost-effectiveness criteria and methodology. This manual is often referenced by many other states and utilities.

[10] The December 2008 National Action Plan for Energy Efficiency (NAPEE) "Vision for 2025: A Framework for Change" states that "the long-term aspirational goal for the Action Plan is to achieve all cost-effective energy efficiency by the year 2025. Based on studies, the efficiency resource available may be able to meet 50% or more of the expected load growth over this time frame, similar to meeting 20% of electricity consumption and 10 percent of natural gas consumption. The benefits from achieving this magnitude of energy efficiency nationally can be estimated to be more than $100 billion in lower energy bills in 2025 than would otherwise occur, over $500 billion in net savings, and substantial reductions in greenhouse gas emissions."

[11] American Council for an Energy Efficient Economy, "The 2010 State Energy Efficiency Scorecard", Report #E107, October 2010.

The GDS cost effectiveness screening tool used for this study quantifies all of the benefits and costs included in these two tests (TRC and UCT tests). For purposes of this study, quantified benefits of the TRC Test include electric energy and capacity avoided supply costs, avoided electric transmission and distribution avoided costs, and alternative fuel and water savings. GDS has also included a risk adjusted value for reduced carbon emissions valued at $9.25 per ton of carbon emissions avoided.[12] Costs include the specified measure cost (incremental or full cost, as applicable), any increase in supply costs (electric or fossil fuel), as well as operation and maintenance costs. In addition, the GDS screening tool is capable of evaluation of cost-effectiveness based on various market replacement approaches, including replace-on-burnout, retrofit, and early retirement.

The forecast of electric and natural gas avoided costs of energy and generation capacity were obtained from the Michigan PSC. The value for electric T&D avoided costs were obtained from a report from the New York Public Service Commission based on the upstate New York region.

This energy efficiency potential study concludes that there remains significant achievable cost effective potential for electric and natural gas energy efficiency measures and programs in Michigan. Tables 3-2, 3-3 and 3-4 show benefit-cost ratios for the three scenarios examined in this study for the five and ten-year implementation periods starting in 2014.

Table 3-2: Scenario #1: Utility Cost Test Benefit-Cost Ratios for the Achievable Potential Scenario Based on UCT Screening (50% Incentives) For 5-Year and 10-Year Implementation Periods

Achievable Potential Scenarios	UCT $ Benefits	UCT $ Costs	UCT Benefit/Cost Ratio
5-yr period	$12,882,773,443	$4,483,103,484	2.87
10-yr period	$22,890,937,898	$7,524,246,046	3.04

Table 3-3: Scenario #2: TRC Test Benefit-Cost Ratios for the Achievable Potential Scenario Based on TRC Screening For 5-Year and 10-Year Implementation Periods

Achievable Potential Scenarios	TRC $ Benefits	TRC $ Costs	TRC Benefit/Cost Ratio
5-yr period	$13,066,208,938	$3,993,036,655	3.27
10-yr period	$22,928,797,332	$6,597,930,173	3.48

Table 3-4: Scenario #3: Benefit-Cost Ratios for the Constrained Achievable Potential Scenario Based on the UCT Test for 5-Year and 10-Year Implementation Periods

Achievable Potential Scenarios	UCT $ Benefits	UCT $ Costs	UCT Benefit/Cost Ratio
5-yr period	$3,902,083,465	$1,378,148,311	2.83
10-yr period	$7,314,471,223	$2,405,262,802	3.04

[12] This value represents the expected value for reduced carbon emissions based on an equal weighting of a scenario with no carbon taxes and a scenario where carbon is valued at $18.50 per ton of reduced emissions. The $18.50 per ton figure was obtained from a recent filing by Commonwealth Edison in Illinois.

4 CHARACTERIZATION OF ELECTRICITY AND NATURAL GAS CONSUMPTION IN MICHIGAN

This chapter provides up-to-date historical and forecast information on electricity and natural gas consumption, consumption by market segment and by energy end use, and electric and natural gas customers in the State of Michigan. This chapter also provides an overview of the number of households and housing units in Michigan. Developing this information is a fundamental part of any energy efficiency potential study. It is necessary to understand how energy is consumed in a state or region before one can assess the energy efficiency savings potential that remains to be tapped.

4.1 MICHIGAN ELECTRIC AND NATURAL GAS UTILITIES

There are multiple utilities that provide electric and natural gas to Michigan customers. Michigan has 9 investor-owned electric utilities, 1 municipal utility, the Michigan Municipal Electric Association (MMEA) which serves several communities in Michigan and 10 electric distribution cooperatives. There are 10 utilities in Michigan that provide piped natural gas to consumers. The two largest electric utilities are DTE Energy Company (DTE) and Consumers Energy. These two utilities provide approximately 92% of electric energy sales in the State.

Figure 4-1 shows the service areas for electric distribution utilities in Michigan, with the largest two companies, DTE and Consumers Energy taking up much of the geographic region of the state. Note that the size of utility service areas varies greatly. Figure 4-2 displays the service areas of the utilities that distribute piped natural gas throughout the state.

Figure 4-1: Michigan Electric Utility Service Territories

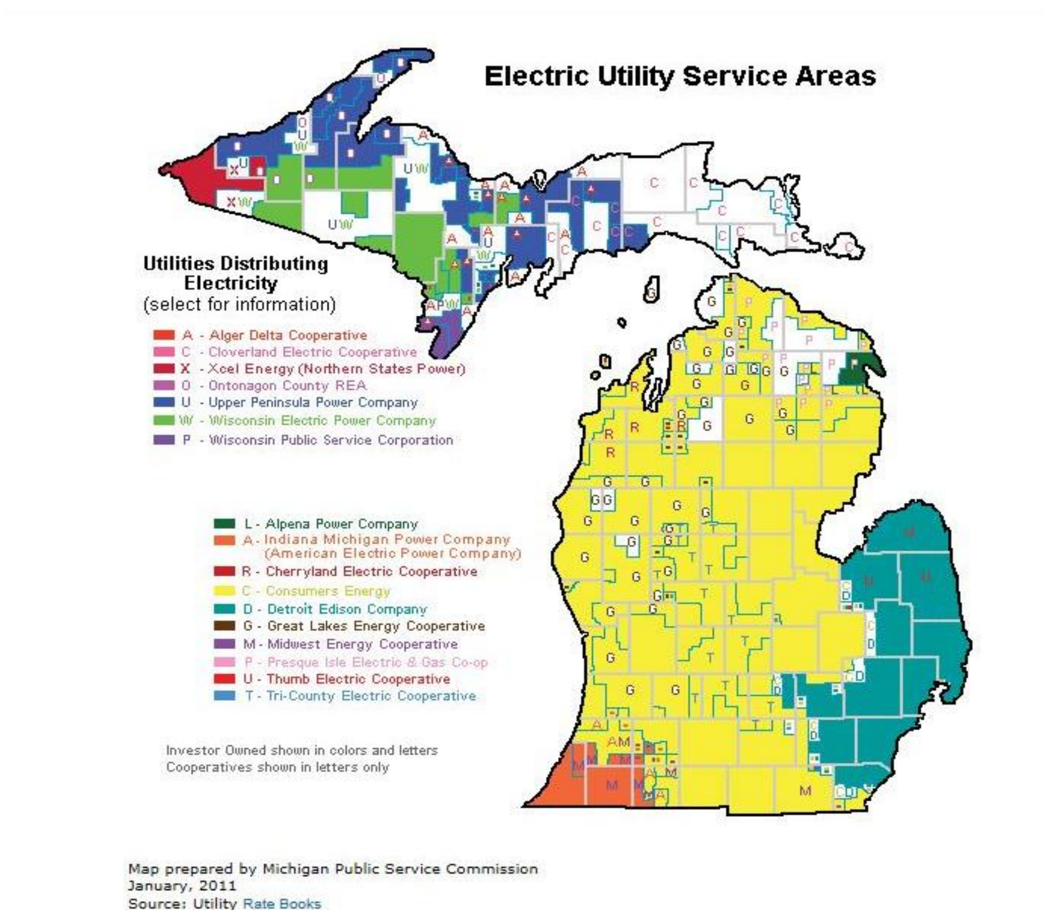
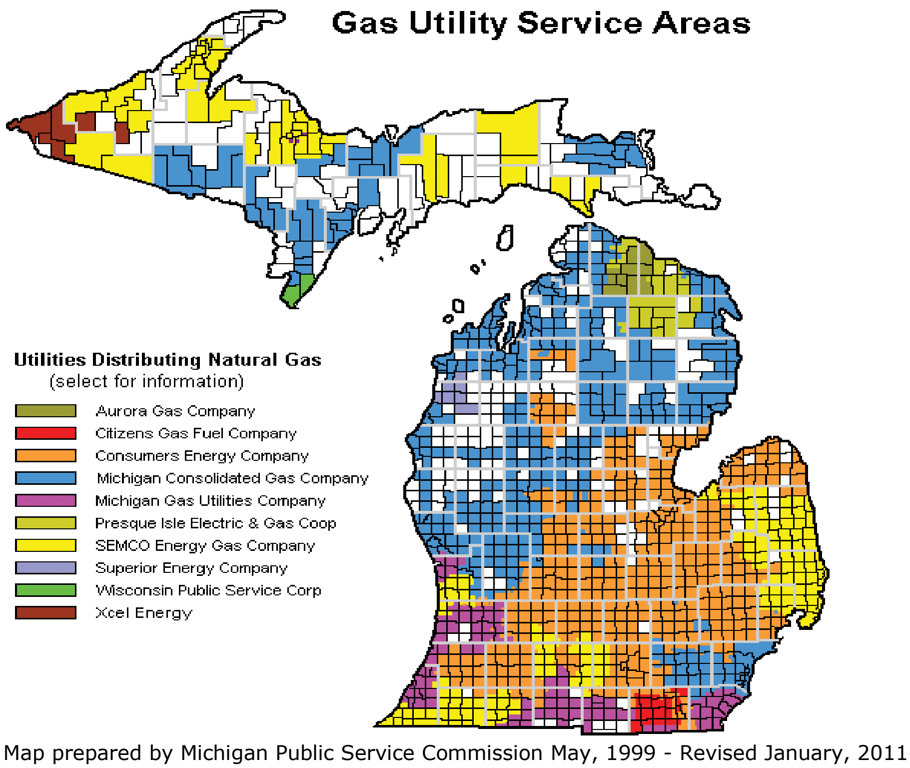


Figure 4-2: Michigan Natural Gas Utility Service Territories



4.1.1 Detroit Edison Energy Company (DTE)

The DTE Energy provides electricity mainly in southeastern Michigan and provides natural gas services throughout the state of Michigan. DTE supplies electricity and natural gas to 2.1 million and 1.2 million customers respectively throughout the entire state.

4.1.2 Consumers Energy

Consumers Energy is one of the largest combined utilities (electric and natural gas) in the country, providing services to a population of 6.8 million of the 10 million citizens in the states.

4.2 ECONOMIC/DEMOGRAPHIC CHARACTERISTIC

Michigan is located in the Great Lakes and the Midwestern region of the United States. It is the 11th largest state. It borders Wisconsin, Ohio, Indiana, Minnesota, and Canada. Michigan is 96,810 square miles, bordering four of the Great Lakes: Lake Michigan, Lake Superior, Lake Huron, and Lake Erie. Michigan's population is 9,883,635 residents[13], ranking Michigan as the 8th most populated state in the country.

According to an estimate done by the Census Bureau, during the year 2012, there were about 175 people per square mile in the state of Michigan. The state's population distribution by age is as follows:

- Under 5 – 7.6%
- Ages 5-19 – 22.6%
- Ages 19-65 - 46.8%
- Above 65 – 23%

[13] U.S. Department of Commerce, Bureau of the Census, at www.census .gov on October 7, 2013.

The estimated number of Michigan housing units from the 2010 census was 4,532,233. Table 4-1 and Table 4-2 provides historical and forecast data for the number of electric and natural gas customers by sector in Michigan.

Table 4-1: Number of Electric Customers by Market Sector

YEAR	RESIDENTIAL ELECTRIC CUSTOMERS	COMMERCIAL ELECTRIC CUSTOMERS	INDUSTRIAL ELECTRIC CUSTOMERS	TOTAL ELECTRIC CUSTOMERS
2003	4,216,573	483,168	14,224	***4,713,965***
2004	4,248,920	504,754	14,322	***4,767,996***
2005	4,284,083	509,964	13,390	***4,807,437***
2006	4,299,273	514,049	13,317	***4,826,639***
2007	4,298,455	518,058	13,227	***4,829,740***
2008	4,290,313	518,776	12,776	***4,821,865***
2009	4,253,786	520,551	13,065	***4,787,402***
2010	4,245,158	520,233	12,827	***4,778,218***
2011	4,249,136	521,322	12,961	***4,783,419***
2012	4,249,100	520,674	12,829	***4,782,603***
2013	4,251,335	522,599	13,070	***4,787,004***
2014	4,258,028	524,034	13,108	***4,795,170***
2015	4,266,512	525,411	13,127	***4,805,050***
2016	4,277,366	526,820	13,139	***4,817,325***
2017	4,289,689	528,188	13,146	***4,831,023***
2018	4,305,113	529,714	13,153	***4,847,980***
2019	4,321,703	531,212	13,160	***4,866,075***
2020	4,338,945	532,660	13,166	***4,884,771***
2021	4,356,733	534,067	13,171	***4,903,971***
2022	4,375,466	535,463	13,177	***4,924,106***
2023	4,395,035	536,848	13,183	***4,945,066***
2024	4,415,254	535,425	13,189	***4,963,868***

Table 4-2: Number of Natural Gas Customers by Market Sector

YEAR	RESIDENTIAL NATURAL GAS CUSTOMERS	COMMERCIAL NATURAL GAS CUSTOMERS	INDUSTRIAL NATURAL GAS CUSTOMERS	TOTAL NATURAL GAS CUSTOMERS
2002	3,110,743	247,818	10,468	**3,369,029**
2003	3,140,021	246,123	10,378	**3,396,522**
2004	3,161,370	246,991	10,088	**3,418,449**
2005	3,187,583	253,415	10,049	**3,451,047**
2006	3,193,920	254,923	9,885	**3,458,728**
2007	3,188,152	253,139	9,728	**3,451,019**
2008	3,172,623	252,382	10,563	**3,435,568**
2009	3,169,026	252,017	18,186	**3,439,229**
2010	3,152,468	249,309	9,332	**3,411,109**
2011	3,153,895	249,456	9,088	**3,412,439**
2012	3,163,925	249,850	8,833	**3,422,609**
2013	3,173,955	250,245	8,579	**3,432,779**
2014	3,183,986	250,639	8,324	**3,442,949**
2015	3,197,789	251,082	8,287	**3,457,158**
2016	3,213,198	251,775	8,250	**3,473,222**
2017	3,228,297	251,653	8,212	**3,488,162**

YEAR	RESIDENTIAL NATURAL GAS CUSTOMERS	COMMERCIAL NATURAL GAS CUSTOMERS	INDUSTRIAL NATURAL GAS CUSTOMERS	TOTAL NATURAL GAS CUSTOMERS
2018	3,243,686	253,195	8,175	**3,505,055**
2019	3,258,606	253,389	8,152	**3,520,147**
2020	3,273,842	253,972	8,120	**3,535,934**
2021	3,289,150	254,559	8,087	**3,551,796**
2022	3,304,524	255,350	8,064	**3,567,938**
2023	3,319,876	255,751	8,035	**3,583,663**
2024	3,335,417	256,451	8,005	**3,599,873**

4.3 COMMERCIAL AND INDUSTRIAL SECTOR BASELINE SEGMENTATION FINDINGS

This section provides detailed information on the breakdown of commercial and industrial electricity and natural gas sales in Michigan by market segment and end use.

4.3.1 Electricity Sales by Sector, by EDC

Figure 4-3 and Table 4-3 show historical and forecast electricity sales by sector (in millions of kWh) for the State of Michigan for the period 2002 to 2024.

Figure 4-3: Michigan Annual Electric Sales

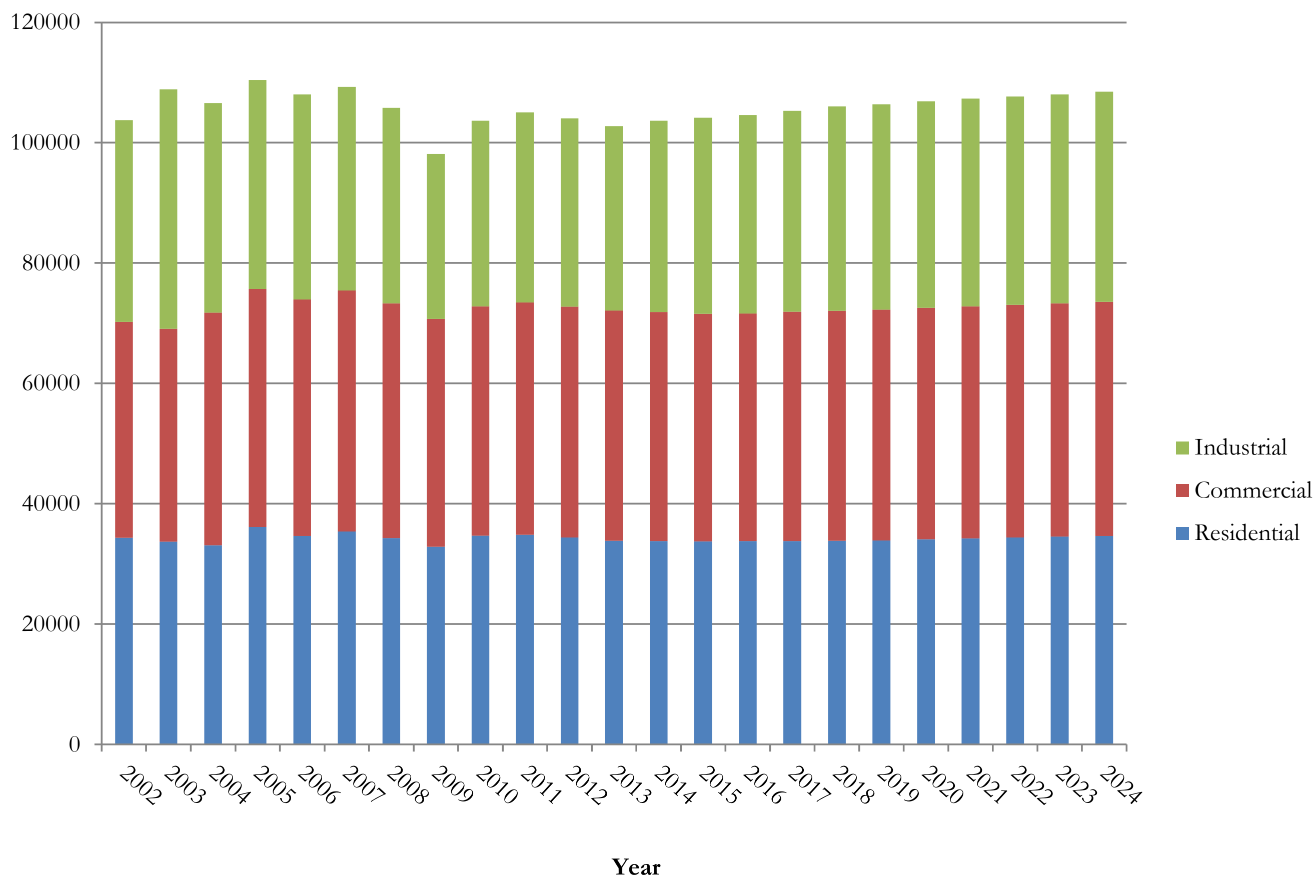


Table 4-3: Michigan Actual and Projected Electric GWh Sales by Sector

YEAR	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	*TOTAL*
2002	34,336	35,880	33,537	***103,753***
2003	33,669	35,391	39,813	***108,873***
2004	33,104	38,632	34,867	***106,603***
2005	36,095	39,600	34,745	***110,440***
2006	34,622	39,299	34,093	***108,014***
2007	35,366	40,047	33,879	***109,292***
2008	34,297	38,974	32,505	***105,776***
2009	32,854	37,870	27,391	***98,115***
2010	34,681	38,123	30,841	***103,645***
2011	34,811	38,613	31,624	***105,048***
2012	34,400	38,367	31,305	***104,072***
2013	33,812	38,289	30,669	***102,770***
2014	33,775	38,075	31,795	***103,645***
2015	33,726	37,822	32,582	***104,130***
2016	33,797	37,807	32,987	***104,591***
2017	33,780	38,114	33,380	***105,274***
2018	33,804	38,236	34,022	***106,062***
2019	33,903	38,349	34,149	***106,401***
2020	34,073	38,458	34,370	***106,901***
2021	34,239	38,561	34,548	***107,348***
2022	34,390	38,660	34,637	***107,687***
2023	34,503	38,789	34,746	***108,038***
2024	34,612	38,947	34,928	***108,487***
Total	**786,649**	**880,903**	**767,413**	**2,434,965**

4.3.2 Natural Gas Sales by Sector, by EDC

Figure 4-4 presents historical and forecast natural gas sales by sector for the State of Michigan (in MMbtu) for the period 2002 to 2022. The commercial sector is the largest sector of natural gas sales, followed by residential and industrial. Table 4-4 presents historical and forecast data in numerical format for natural gas sales in Michigan by sector for the period 2002 to 2024.

Figure 4-4: Michigan Natural Gas Sales Forecast (MMBtu)

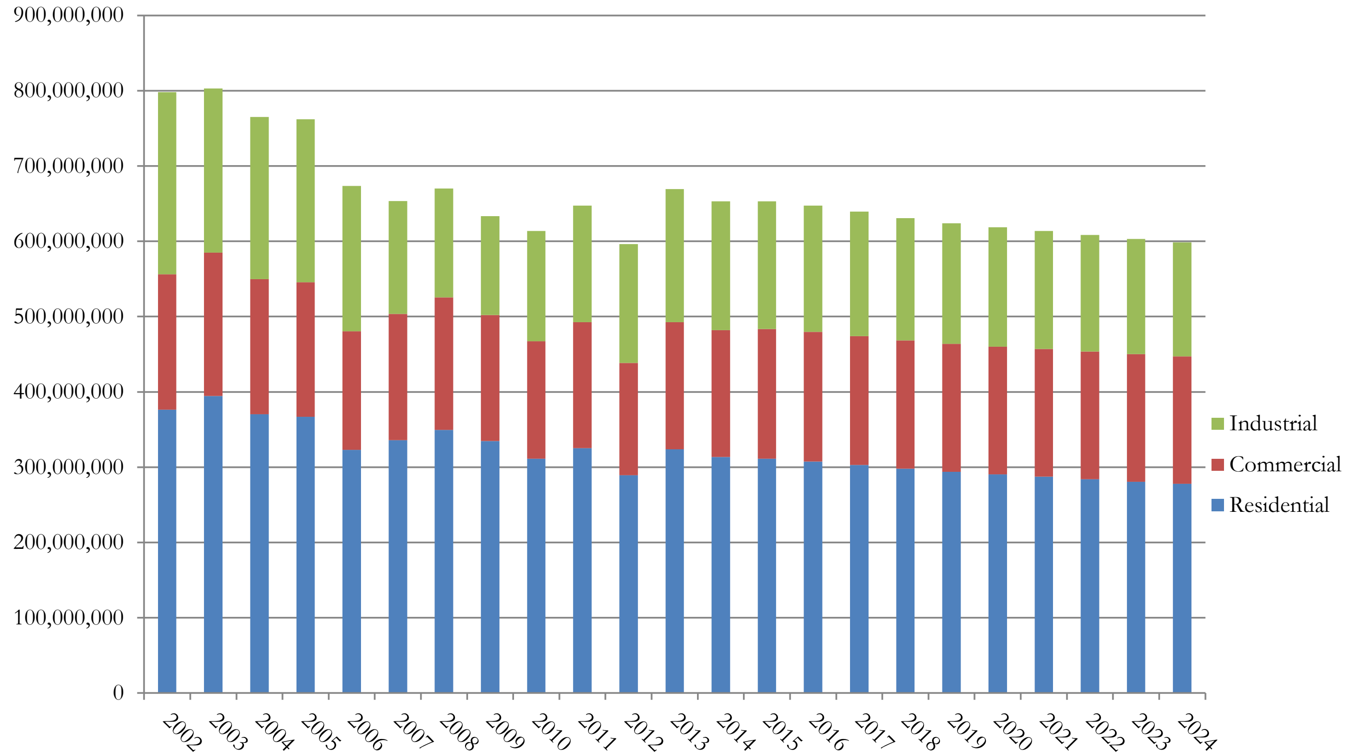


Table 4-4: Michigan Actual and Projected Natural Gas Sales by Sector (MMBtu)

YEAR	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TOTAL
2002	376,223,595	180,058,230	241,564,059	**797,845,884**
2003	394,436,064	190,409,967	218,156,796	**803,002,827**
2004	370,350,552	179,219,370	215,342,523	**764,912,445**
2005	366,871,329	178,641,375	216,404,397	**761,917,101**
2006	323,031,687	157,435,608	192,843,684	**673,310,979**
2007	335,985,936	167,506,020	149,956,455	**653,448,411**
2008	349,614,342	176,066,484	144,429,186	**670,110,012**
2009	334,636,599	167,447,709	131,459,592	**633,543,900**
2010	311,329,590	155,854,050	146,648,073	**613,831,713**
2011	325,318,092	167,329,041	154,557,909	**647,205,042**
2012	289,473,195	149,024,502	157,851,969	**596,349,666**
2013	323,647,533	169,062,003	176,487,960	**669,197,496**
2014	313,567,914	168,397,053	170,991,381	**652,956,348**
2015	311,401,200	171,899,805	169,809,816	**653,110,821**
2016	307,589,502	172,012,335	167,731,080	**647,332,917**
2017	302,872,449	171,290,097	165,158,235	**639,320,781**
2018	297,890,439	170,273,235	162,442,170	**630,605,844**
2019	293,841,405	169,924,392	160,234,536	**624,000,333**
2020	290,497,218	169,632,837	158,410,527	**618,540,582**
2021	287,348,424	169,585,779	156,693,933	**613,628,136**
2022	284,092,215	169,475,295	154,918,005	**608,485,515**
2023	280,796,109	169,323,891	153,119,571	**603,239,571**
2024	277,777,236	169,401,639	151,474,587	**598,653,462**
Total	7,348,592,625	3,909,270,717	3,916,686,444	**15,174,549,786**

4.3.3 Electricity Consumption by Market Segment

Figure 4-5 shows the breakdown of electricity consumption by building type for the commercial sector. Figure 4-6 shows a similar breakdown of sales by industrial market segment for the industrial sector. The Office market sector (29%) consumes the largest share of commercial electricity consumption, followed by Other (21%) and Retail (11%). In the industrial sector, Transportation Equipment (25% of annual industrial electricity sales) is the largest sector, followed by Primary Metals (20%) and Chemistry (10%).

Figure 4-5: 2014 Commercial Electricity Consumption by Market Segment

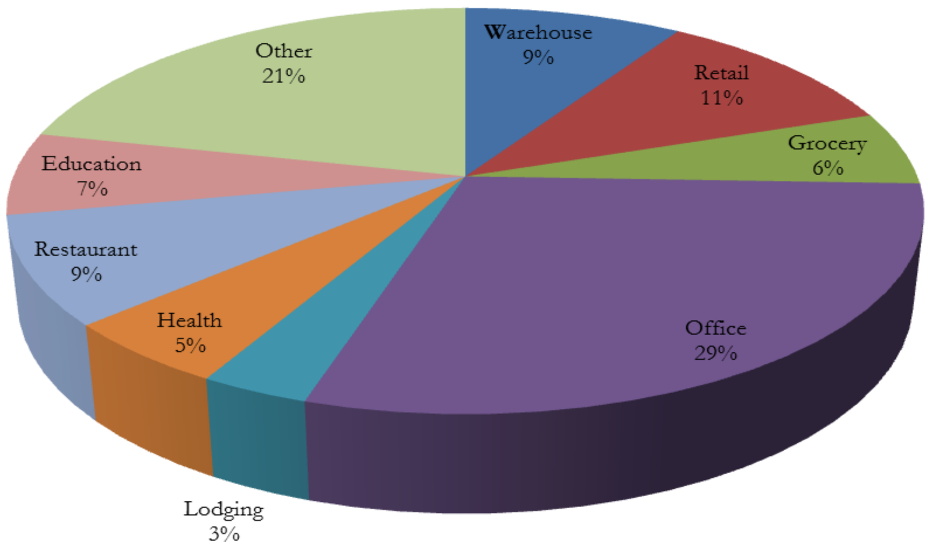


Figure 4-6: 2014 Electric Industrial Energy Consumption by Market Segment

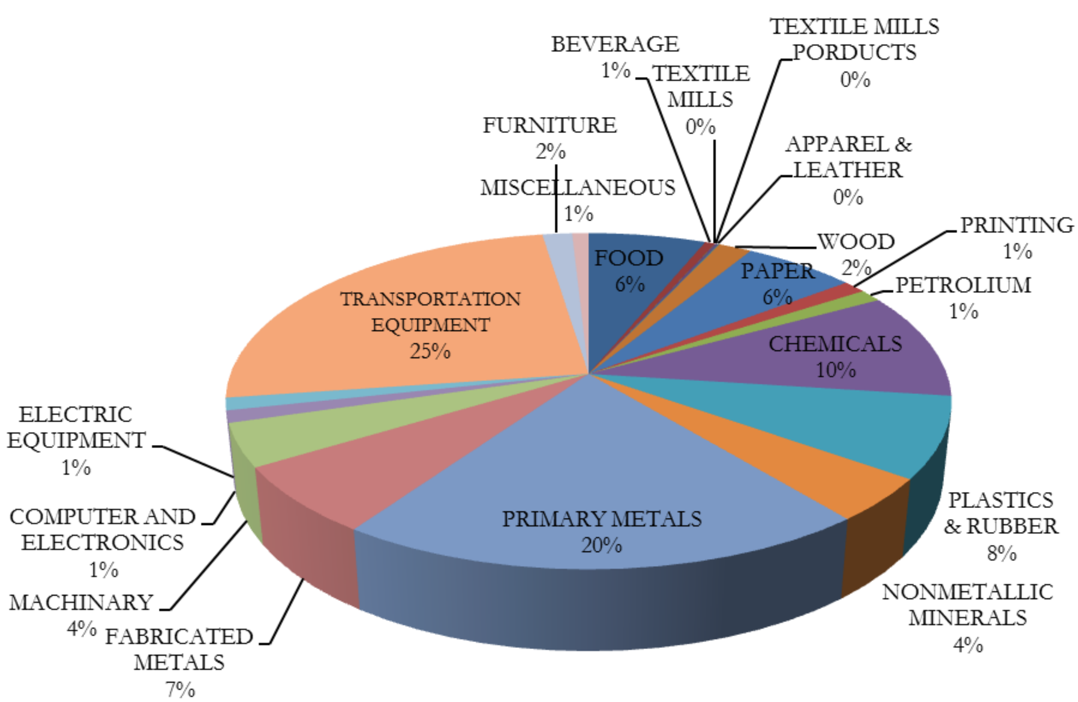


Table 4-5: 2014 Electric Industrial Energy Consumption by Segment

SEGMENT	CONSUMPTION (MWH)	ELECTRICITY SHARE
Food	1,944,291	6%
Beverage	171,696	1%
Textile Mills	3,070	0%
Textile Mill Products	51,185	0%
Apparel & Leather	19,863	0%
Wood	551,294	2%
Paper	1,871,906	6%
Printing	383,711	1%
Petroleum	378,873	1%
Chemicals	3,238,019	10%
Plastics & Rubber	2,481,706	8%
Nonmetallic Minerals	1,342,118	4%
Primary Metals	6,515,086	20%
Fabricated Metals	2,102,667	7%
Machinery	1,321,084	4%
Computer & Electronics	368,783	1%
Electric Equipment	380,700	1%
Transportation Equipment	7,904,144	25%
Furniture	492,726	2%
Miscellaneous	271,813	1%
Total	**31,794,736**	**100%**

4.3.4 Electric Consumption by End-Use

Table 4-6 shows the breakdown of electric energy consumption by commercial market segment by end use. Tables 4-7, 4-8, and 4-9 show the same breakdown for the industrial sector by market segment. Lighting is the largest end use for the commercial sector (37% of commercial sector electricity consumption), followed by cooling (14%), and then by ventilation (13%). As for the industrial sector, machine drives represent the largest end use, followed by process heating and facility HVAC

Table 4-6: Breakdown of Michigan Commercial Electricity Sales by Market Segment and End-Use

	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other	Total
Lighting	54%	42%	22%	39%	54%	42%	19%	31%	32%	**37%**
Cooling	6%	15%	6%	14%	10%	14%	13%	21%	17%	**14%**
Ventilation	8%	9%	3%	9%	6%	16%	11%	22%	24%	**13%**
Water Heating	1%	5%	1%	1%	4%	1%	5%	3%	1%	**2%**

	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other	Total
Refrigeration	14%	7%	55%	5%	4%	3%	32%	5%	9%	**12%**
Space Heating	1%	8%	3%	5%	6%	3%	5%	4%	4%	**4%**
Office Equipment	3%	2%	3%	15%	3%	5%	2%	9%	2%	**7%**
Miscellaneous	13%	12%	6%	13%	12%	15%	13%	6%	11%	**12%**
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-7: Electric Industrial Energy Consumption by End Use (Table 1 of 3)

	FOOD	BEVERAGE	TEXTILE MILLS	TEXTILE MILL PRODUCTS	APPAREL & LEATHER	WOOD	PAPER
Conventional Boiler Use	3%	2%	1%	1%	1%	1%	2%
Process Heating	5%	6%	7%	9%	6%	6%	3%
Process Cooling and Refrigeration	28%	26%	9%	6%	4%	1%	1%
Machine Drive	43%	34%	54%	47%	36%	72%	75%
Electro-Chemical Processes	0%	0%	1%	1%	1%	1%	1%
Other Process Use	1%	2%	3%	1%	2%	1%	4%
Facility HVAC (g)	8%	10%	12%	16%	26%	6%	4%
Facility Lighting	8%	8%	8%	15%	16%	8%	4%
Other Facility Support	2%	2%	2%	3%	4%	2%	1%
Onsite Transportation	0%	0%	0%	0%	0%	0%	0%
Other Nonprocess Use	0%	0%	0%	0%	0%	1%	0%
End Use Not Reported	2%	9%	3%	1%	4%	2%	4%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-8: Electric Industrial Energy Consumption by End Use (Table 2 of 3)

	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBERS	NONMETALLIC MINERAL	PRIMARY METALS
Conventional Boiler Use	1%	1%	1%	1%	0%	0%
Process Heating	4%	0%	4%	18%	26%	32%

	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBERS	NONMETALLIC MINERAL	PRIMARY METALS
Process Cooling and Refrigeration	5%	5%	8%	11%	3%	1%
Machine Drive	46%	83%	59%	43%	54%	28%
Electro-Chemical Processes	1%	0%	15%	0%	1%	26%
Other Process Use	1%	2%	1%	3%	2%	3%
Facility HVAC (g)	24%	4%	6%	10%	6%	4%
Facility Lighting	9%	3%	4%	8%	5%	3%
Other Facility Support	3%	1%	1%	2%	1%	1%
Onsite Transportation	0%	0%	0%	0%	0%	0%
Other Nonprocess Use	1%	0%	0%	0%	0%	0%
End Use Not Reported	4%	2%	1%	2%	1%	0%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4-9: Electric Industrial Energy Consumption by End Use (Table 3 of 3)

	FABRICATED METALS	MACHINERY	COMPUTERS & ELECTRONICS	ELEC. EQUIP.	TRANS EQUIP.	FURNITURE	MISC.	TOTAL INDUSTRIAL
Conventional Boiler Use	0%	1%	1%	1%	1%	1%	1%	**277,716**
Process Heating	21%	11%	10%	15%	11%	5%	11%	**4,816,452**
Process Cooling and Refrigeration	3%	3%	9%	4%	5%	1%	5%	**1,868,622**
Machine Drive	41%	40%	23%	37%	36%	47%	30%	**13,500,396**
Electro-Chemical Processes	3%	0%	2%	5%	2%	1%	5%	**2,521,134**
Other Process Use	3%	3%	5%	4%	4%	2%	3%	**889,721**
Facility HVAC (g)	9%	20%	30%	15%	19%	18%	25%	**3,445,271**
Facility Lighting	11%	15%	12%	10%	15%	17%	14%	**2,754,603**
Other Facility Support	2%	4%	5%	7%	3%	4%	4%	**716,870**
Onsite Transportation	0%	0%	0%	0%	1%	1%	0%	**93,715**
Other Nonprocess Use	0%	1%	1%	0%	1%	1%	0%	**175,298**
End Use Not Reported	6%	1%	4%	0%	3%	4%	1%	**734,938**
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**31,794,736**

4.3.5 Natural Gas Consumption by Market Segment

Figure 4-7 shows the breakdown of Michigan natural gas sales by commercial market segment. Figure 4-8 and Table 4-10 show a similar breakdown for the industrial market segment. The Other segment (23%) consumes the largest share of the commercial sector natural gas consumption, followed by the Office (21%) and Education (15%) market segments. In the industrial sector, the Chemicals (21%) market segment consumes the largest amount of natural gas, followed by Transportation Equipment (19%) and Primary Metals (13%). 2010 EIA MECS End Use Data was used to obtain end use percentage breakdowns of electricity and natural gas use for each major industrial NAICS category at the national level. 2011 Census data for each major industrial NAICS category was used to obtain electricity use and fuel consumption as well as value of product shipments for each category. This was used to generate MWh of electricity per dollar of product shipped and MMBtu of natural gas per dollar of product shipped for each NAICS category, and these ratios were multiplied by the Michigan-specific values of product shipped per NAICS category to obtain estimated 2011 MWh of electricity consumption and MMBtu of natural gas consumption per NAICS category in Michigan and percent of total industrial electricity and natural gas consumption represented by each NAICS category. These NAICS category percentages were then multiplied by forecasted Michigan Industrial electricity and gas consumption for 2014 and 2023 to assign the forecasted consumption to each NAICS category. The end use percentage breakdowns were then applied to forecasted total consumption for each SIC category to obtain estimated electricity and natural gas consumption for each end use in each Industrial NAICS category for 2014 and 2023

Figure 4-7: Natural Gas *Commercial* Energy Consumption by Market Segment

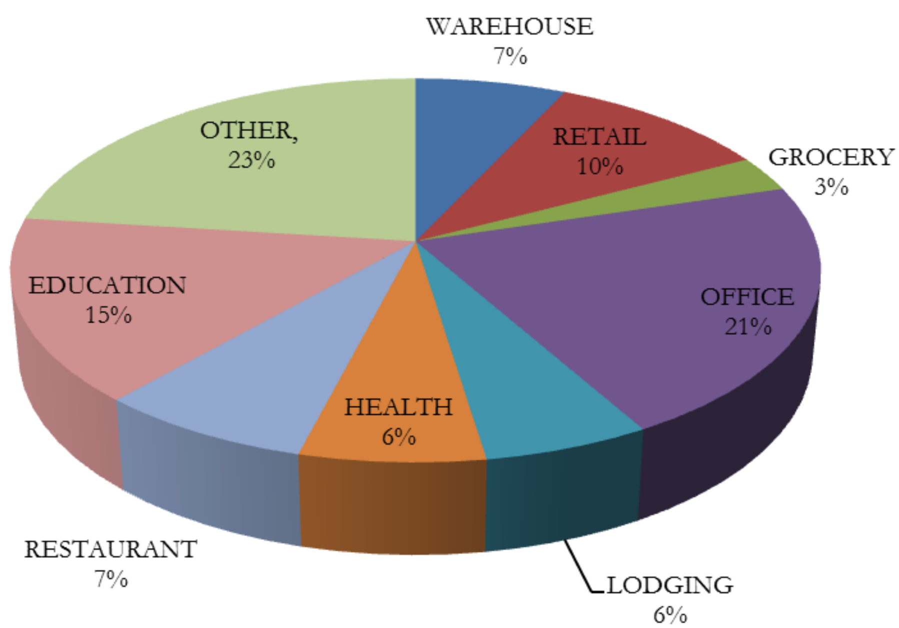


Figure 4-8: Natural Gas *Industrial Energy* Consumption by Market Segment

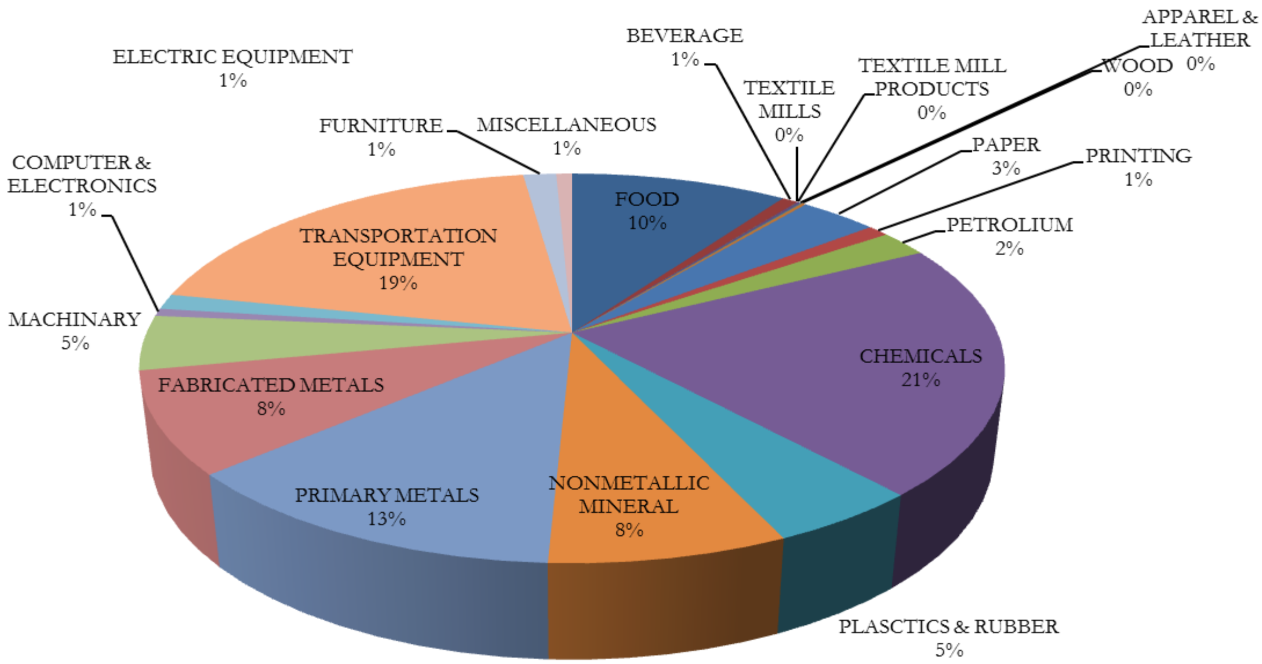


Table 4-10: Natural Gas *Industrial* Energy Consumption by Market Segment

SEGMENT	CONSUMPTION (MWH)	ELECTRICITY SHARE
Food	16,642,808	10%
Beverage	1,224,421	1%
Textile Mills	13,049	0%
Textile Mill Products	274,779	0%
Apparel & Leather	104,123	0%
Wood	331,865	0%
Paper	5,978,556	3%
Printing	1,635,620	1%
Petroleum	3,749,816	2%
Chemicals	36,124,119	21%
Plastics & Rubber	8,302,233	5%
Nonmetallic Minerals	12,978,192	8%
Primary Metals	21,883,749	13%
Fabricated Metals	14,532,992	8%
Machinery	7,828,921	5%
Computer & Electronics	1,082,742	1%
Electric Equipment	2,198,993	1%

SEGMENT	CONSUMPTION (MWH)	ELECTRICITY SHARE
Transportation Equipment	33,526,892	19%
Furniture	2,534,560	1%
Miscellaneous	1,212,561	1%
Total	172,160,990	100%

4.3.6 Natural Gas Consumption by End-Use

Table 4-11 shows the breakdown of natural gas consumption by commercial market segment by end use. Tables 4-12, 4-13, and 4-14 show the same breakdown for the industrial sector. The largest natural gas end use in the commercial sector is space heating, followed by water heating and cooking. In the industrial sector, the largest end use is process heating.

Figure 4-11: Natural Gas *Commercial Energy* Consumption by End-Use

	Warehouse	Retail	Grocery	Office	Lodging	Health	Restaurant	Education	Other
Space Heating	84%	71%	69%	86%	30%	56%	27%	77%	85%
Water Heating	3%	7%	5%	5%	58%	30%	23%	14%	4%
Cooking	0%	9%	21%	1%	7%	4%	45%	2%	8%
Other	13%	13%	5%	9%	6%	9%	6%	7%	0%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**98%**

Figure 4-12: Natural Gas *Industrial Energy* Consumption by End-Use (Table 1 of 3)

	FOOD	BEVERAGE	TEXTILE MILLS	TEXTILE MILL PRODUCTS	APPAREL & LEATHER	WOOD	PAPER
Conventional Boiler Use	28%	24%	26%	25%	25%	6%	13%
Process Heating	30%	24%	35%	38%	25%	62%	30%
CHP and/or Cogeneration Process	29%	41%	29%	25%	25%	18%	48%
Facility HVAC (g)	6%	11%	6%	13%	25%	12%	4%
Process Cooling and Refrigeration	0%	0%	0%	0%	0%	0%	0%
Machine Drive	1%	0%	0%	0%	0%	3%	3%
Other Process Use	1%	0%	0%	0%	0%	0%	1%
End Use Not Reported	1%	0%	3%	0%	0%	0%	2%
Other Facility Support	3%	0%	0%	0%	0%	0%	0%
Other Nonprocess Use	0%	0%	0%	0%	0%	0%	0%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure 4-13: Natural Gas *Industrial Energy* Consumption by End-Use (Table 2 of 3)

	PRINTING	PETROLEUM	CHEMICALS	PLASTICS & RUBBER	NONMETALLIC MINERAL	PRIMARY METALS
Conventional Boiler Use	10%	12%	17%	19%	1%	4%
Process Heating	45%	56%	35%	35%	87%	75%
CHP and/or Cogeneration Process	13%	22%	39%	24%	3%	8%
Facility HVAC (g)	29%	0%	1%	22%	6%	7%
Process Cooling and Refrigeration	0%	1%	0%	0%	0%	1%
Machine Drive	3%	2%	4%	0%	1%	2%
Other Process Use	0%	3%	3%	0%	0%	3%
End Use Not Reported	0%	4%	0%	0%	2%	0%
Other Facility Support	0%	0%	0%	1%	0%	1%
Other Nonprocess Use	0%	0%	0%	0%	0%	0%
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Figure 4-14: Natural Gas *Industrial Energy* Consumption by End-Use (Table 3 of 3)

	FABRICATED METALS	MACHINERY	COMPUTER & ELECTRONICS	ELEC. EQUIP.	TRANS. EQUIP.	FURNITURE	MISC.	TOTAL INDUSTRIAL
Conventional Boiler Use	8%	4%	27%	11%	11%	0%	13%	**20,759,627**
Process Heating	63%	41%	12%	54%	35%	46%	27%	**79,914,353**
CHP and/or Cogeneration Process	7%	4%	7%	9%	14%	8%	20%	**33,762,602**
Facility HVAC (g)	20%	48%	44%	20%	33%	46%	40%	**26,638,960**
Process Cooling and Refrigeration	0%	0%	0%	0%	0%	0%	0%	**362,627**
Machine Drive	1%	1%	0%	0%	0%	0%	0%	**2,515,680**
Other Process Use	1%	0%	2%	0%	6%	0%	0%	**4,008,079**
End Use Not Reported	0%	0%	5%	3%	1%	0%	0%	**1,165,518**
Other Facility Support	1%	1%	2%	3%	2%	0%	0%	**1,754,341**
Other Nonprocess Use	0%	0%	0%	0%	0%	0%	0%	**109,175**
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**170,990,963**

4.4 CURRENT MICHIGAN EDC ENERGY EFFICIENCY PROGRAMS

4.4.1 Current DTE Energy Efficiency Programs

DTE Energy provides several energy efficiency programs to Michigan electric and natural gas customers in the residential, commercial and industrial markets.

4.4.1.1 Residential Programs

Residential Energy Efficiency Program (Electric)

DTE offers energy audit discounts and rebates for the installation of energy efficiency improvements. Eligible measures and equipment includes: programmable thermostats, energy audits, insulation, central ac systems, appliance recycling, and air sealing.

Residential Energy Efficiency Program (Gas)

Rebate levels vary according to whether the customer receives MichCon gas, DTE electric service, or both. Eligible measures and equipment include the following high efficiency appliances: clothes washers, dehumidifiers, programmable thermostats, energy audits, insulation, high efficiency room air conditioners, appliance recycling, furnaces, boilers, air sealing, and energy audit. Rebate amounts can also vary based on equipment size and efficiency level. Participation is first come-first serve, and an energy audit should be completed prior to equipment installations.

4.4.1.2 Commercial/ Industrial Programs

Commercial and Industrial Energy Efficiency Program (Electric)

DTE Energy's commercial 'Your Energy Savings Program' provides incentives to commercial and industrial customers who utilize energy efficiency upgrades in their facilities. Some energy efficient technologies eligible for this program include refrigerators, heat pumps, programmable thermostats, vending machine controls, and LED lighting. Custom incentives are based on estimated annual energy savings. Final applications are to be received within 60 days after project completion or by November 30 of the program's year, whichever comes first.

Commercial and Industrial Energy Efficiency Program (Gas)

DTE Energy's commercial 'Your Energy Savings Program' provides prescriptive incentives, mainly on a per unit basis. Some energy efficient technologies eligible for this program include water heaters, equipment insulations, boilers, tankless water heaters, steam system upgrades, windows/roofs, and several other pieces of equipment. Custom incentives are based on annual energy savings and apply to all energy efficiency improvement measures that are not eligible for a prescriptive incentive. The New Construction and Remodeling Program provide assistance in design and incentives for more efficient buildings that purchase and install energy-efficiency equipment.
Participants qualifying for energy efficiency measures in the DTE's service area can participate in the program only by having these measures installed in a business facility. This energy program will only pay incentives for energy saved in facilities in the DTE service areas. Final applications received within 60 days after project completion or by December 15 of the program year, whichever comes first.

Commercial New Construction Energy Efficiency Program

New construction and remodeling projects must entail a facility improvement that verifiable electrical savings (kWh) and/or natural gas energy savings (MCF). This utility rebate program provides incentives for comprehensive measures/whole buildings applicable in commercial, industrial, and construction sectors. Some incentives include: 10% - 20% energy savings: $0.08 per kWh and $4.00 per MCF, 20% - 30% energy savings: $0.10 per kWh and $6.00 per MCF, 30% or more energy savings: $0.12 per kWh and $8.00 per MCF. All non-prescriptive measures must pass a Total Resource Cost (TRC) Test.

4.4.1.3 Solar Programs

Solar Current Programs

Incentives through the Solar Currents program are offered to electric customers that install photovoltaic systems that have capacities within the range 1kW-20kW. For residential customers, the program offers both an up-front rebate of $0.20 per DC watt and a production incentive of $0.03 per kilowatt-hour (kWh) for the renewable energy credits (RECs) until August 31, 2029. Non-residential customers are eligible for incentives for photovoltaic equipment that are $0.13/Watt upfront and $0.02/Watt for the payment of Renewable Energy Credits (RECs).

This program is being offered as part of DTE Energy's compliance plan under the state Renewable Portfolio Standard. Funding for this will be in four rounds, with 500 kW of installations expected per round. Pricing is reviewed after each offering. For the first round of offerings, 1.5 MW is reserved for residential systems, and 0.5 MW is reserved for non-residential. The four application periods will open according to the following dates, respectively: 01/07/2013, 06/24/2013, 01/2014, and 06/2014.

4.4.2 Current Consumers Energy Efficiency Programs

Consumer Energy provides several energy efficiency programs regarding electric and gas for both commercial and residential markets.

4.4.2.1 Residential Programs

Residential Energy Efficiency Program (Electric)

Customers must install equipment in the Consumers Energy service area and receive electric service from Consumers Energy for the appliance purchased in order to apply for rebates. Heat pumps, central air conditioners, building insulation, and clothes washers are just several eligible pieces of equipment that can receive incentives.

Residential Energy Efficiency Program (Gas)

High efficiency furnaces, boilers, water heating units, insulation, windows, doors, energy audits and comprehensive improvements are eligible under this program. Residential Gas customers will be eligible to apply for a range of rebates.

4.4.2.2 Commercial Programs

Commercial Energy and Efficiency (Electric)

Incentives are available for energy efficiency equipment upgrades and are paid based on quantity, size, and efficiency of the equipment. Incentives are available for projects where the payback period is within 1 to 10 years. A bonus incentive of 15% may be available to customers who purchase equipment manufactured in Michigan.

Commercial Energy and Efficiency (Gas)

Incentives are available for energy efficiency equipment upgrades and are paid based on the quantity, size and efficiency of the equipment. Energy efficiency projects that have a payback year between 1-10 years may receive an incentive. A bonus incentive of 15% may be available to customers who purchase equipment manufactured in Michigan. Equipment measures not available for incentives are as follows: fuel switching, projects that involve peak-seeking, and changes in operational and/or maintenance practices.

5 POTENTIAL STUDY METHODOLOGY

This section describes the overall methodology that was utilized by GDS to develop the energy efficiency potential study for the State of Michigan. The main objective of this energy efficiency potential study is to quantify the technical, economic and achievable potential for electric and natural gas energy efficiency savings in Michigan. This report provides estimates of the potential kWh and kW electric savings and MMBtu gas savings for each level (technical, economic and achievable potential) of energy efficiency potential. This document describes the general steps and methods that were used at each stage of the analytical process necessary to produce the various estimates of energy efficiency potential.

Energy efficiency potential studies involve a number of analytical steps to produce estimates of each type of energy efficiency potential: technical, economic, and achievable. This study utilizes benefit/cost screening tools for the residential and non-residential sectors to assess the cost effectiveness of energy efficiency measures. These cost effectiveness screening tools are Excel-based models that integrate technology-specific impacts and costs, customer characteristics, utility avoided cost forecasts and more. Excel was used as the modeling platform to provide transparency to the estimation process and allow for simple customization based on Michigan's unique characteristics and the availability of specific model input data. The major analytical steps and an overview of the potential savings are summarized below, and specific changes in methodology from one sector to another have been noted throughout this section.

- Measure List Development
- Measure Characterization
- Load Forecast Development and Disaggregation
- Potential Savings Overview
- Technical Potential
- Measure Cost-Effectiveness Screening
- Economic Potential
- Achievable Potential

MEASURE LIST DEVELOPMENT

The energy efficiency measures included in this study cover energy efficiency measures included in the Michigan energy measures database (MEMD), additional measures suggested by interested stakeholders, as well as other measures based on the GDS Team's existing knowledge and current databases of electric and natural gas end-use technologies and energy efficiency measures. The study scope includes measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures are of the most immediate interest to DSM program planners in Michigan. However, a small number of well documented emerging technologies were considered for each sector. Emerging technology research was focused on measures that are commercially available but may not be widely accepted at the current time. In June 2013, the GDS Team provided the energy efficiency measure lists for each sector to interested stakeholders for review and comment. These measure lists were then reviewed, discussed and updated as necessary. A complete listing of the energy efficiency measures included in this study is provided in the Appendices of this report.

In addition, this study includes measures that could be relatively easily substituted for, or applied to, existing technologies on a retrofit or replace-on-burnout basis. Replace-on-burnout applies to equipment replacements that are made normally in the market when a piece of equipment is at the end of its useful life. A retrofit measure is eligible to be replaced at any time in the life of the equipment or building. Replace-on-burnout measures are generally characterized by incremental measure costs and savings (*e.g.*

the costs and savings of a high-efficiency versus standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g. the full costs and savings associated with adding ceiling insulation into an existing attic). For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction.

MEASURE CHARACTERIZATION

A significant amount of data is needed to estimate the kWh, kW and MMBtu savings potential for individual energy efficiency and demand response measures or programs across the entire existing residential and non-residential sectors in Michigan. GDS used Michigan specific data wherever it was available and up-to-date. Considerable effort was expended to identify, review, and document all available data sources.[14] This review has allowed the development of reasonable and supportable assumptions regarding: measure lives; measure installed incremental or full costs (as appropriate); and electric and natural gas savings and saturations for each energy efficiency measure included in the final list of measures in this study.

Costs and savings for new construction and replace on burnout measures are calculated as the incremental difference between the code minimum equipment and the energy efficiency measure. This approach is utilized because the consumer must select an efficiency level that is at least the code minimum equipment. The incremental cost is calculated as the difference between the cost of high efficiency and standard (code compliant) equipment. However, for retrofit measures, the measure cost was considered to be the "full" cost of the measure, as the baseline scenario assumes the consumer would do nothing. In general, the savings for retrofit measures are calculated as the difference between the energy use of the removed equipment and the energy use of the new high efficiency equipment (until the removed equipment would have reached the end of its useful life).

Savings: Estimates of annual measure savings as a percentage of base equipment usage were developed from a variety of sources, including:

- Michigan Energy Measures Database
- Secondary sources such as the American Council for an Energy-Efficient Economy ("ACEEE"), Department of Energy ("DOE"), Energy Information Administration ("EIA"), ENERGY STAR, Air Conditioning Contractors of America ("ACCA") and other technical potential studies and Technical Reference Manuals

Measure Costs: Measure costs represent either incremental or full costs, and typically include the incremental cost of measure installation. For purposes of this study, nominal measures costs were held constant over time. This general assumption is being made due to the fact that historically many measure costs (e.g., CFL bulbs, Energy Star appliances, etc.) have declined over time, while some measure costs have increased over time (e.g., fiberglass insulation). The one exception to this general assumption was that LED bulb costs were assumed to decline over time. This exception was included as directed by the Public Staff of the Michigan Public Service Commission (MPSC), and is grounded by the observation of rapidly declining LED bulb costs over the last several years, as well as the relatively high contribution of LED bulbs to the overall estimates of savings potential. Cost estimates were obtained from the following types of data sources:

- Michigan Energy Measures Database
- Secondary sources such as ACEEE, ENERGY STAR, NREL, NEEP Incremental Cost Study Report, and other technical potential studies and Technical Reference Manuals
- Retail store pricing (such as web sites of Home Depot and Lowe's) and industry experts

[14] The appendices and supporting databases to this report provide the data sources used by GDS to obtain up-to-date data on energy efficiency measure costs, savings, useful lives and saturations.

Measure Life: Represents the number of years that energy-using equipment is expected to operate. Useful life estimates have been obtained from the following data sources:

- Michigan Energy Measures Database
- Manufacturer data
- Savings calculators and life-cycle cost analyses
- Secondary sources such as ACEEE, ENERGY STAR, and other technical potential studies
- The California Database for Energy Efficient Resources ("DEER") database
- Evaluation reports
- GDS and other consultant research or technical reports

Baseline and Efficient Technology Saturations: In order to assess the amount of electric and natural gas energy efficiency savings still available, estimates of the current saturation of baseline equipment and energy efficiency measures, or for the non-residential sector the amount of energy use that is associated with a specific end use (such as HVAC) and percent of that energy use that is associated with energy efficient equipment are necessary. Up-to-date measure saturation data were primarily obtained from the following recent studies:

- 2011 Michigan Residential Baseline Study conducted by the MPSC
- Energy efficiency baseline studies conducted by DTE Energy and Consumers Energy
- 2011 Michigan Commercial Baseline Study conducted by the MPSC
- 2009 EIA Residential Energy Consumption Survey (RECS)
- 2007 American Housing Survey (AHS)
- 2010 EIA Manufacturing Energy Consumption Survey (MECS)
- 2003 EIA Commercial Building Energy Consumption Survey (CBECS)

Further detail regarding the development of measure assumptions for energy efficiency in the residential and non-residential sectors are provided in this report in later sections. Additionally, as noted above, the appendices of the report provide a comprehensive listing of all energy efficiency measure assumptions and data sources.

FORECAST DISAGGREGATION FOR THE COMMERCIAL AND INDUSTRIAL SECTORS

For the commercial sector, the baseline electric and natural gas load forecasts were disaggregated by combining sales breakdowns by business type provided by DTE Energy with regional energy use estimates by business type available from the U.S. Energy Information Administration (EIA)[15] The forecasts were then further disaggregated by end use based on end use consumption estimates for the East North Central Region (Michigan, Wisconsin, Ohio, Indiana, Illinois). The disaggregated electric and natural gas sales forecasts provide the foundation for the development of energy efficiency potential estimates for the commercial sector. It was not necessary to develop a disaggregated residential sales forecast because a bottom-up approach was used for the residential sector.

For the industrial sector, the baseline electric and natural gas demand forecasts were disaggregated by industry type and then by end use. The industry type breakdowns are based on Michigan value of shipments data and U.S. energy intensity data (consumption per $ of value shipped) by industry from the U.S. Census Bureau's Annual Survey of Manufacturers. Further dis-aggregation by end use is based on

[15] 2003 EIA Commercial Building Energy Consumption Survey (CBECS), East North Central and Midwest Regions.

data from the EIA's 2010 Manufacturing Energy Consumption Survey (MECS) The disaggregated forecast data provides the foundation for the development of energy efficiency potential estimates for the industrial sector.

ROLE OF NATURALLY OCCURRING CONSERVATION

Naturally occurring conservation exists through government intervention, improved manufacturing efficiencies, building energy codes, market demand, and increased energy efficiency implementation by early adopters, who will implement measures without explicit monetary incentives. The impacts of new Federal government mandated energy efficiency standards have already been reflected in the baseline data for equipment unit energy consumption being used for this potential study. These new government standards, such as the new standards included in the Federal government's December 2007 Energy Independence and Security Act (EISA)[16], can significantly increase naturally occurring potential through tax incentives, stimulus funding or stricter manufacturing standards. These forces cause certain sector end-use energy consumption values to improve across the baseline forecast. It is important to account for these forces as thoroughly as possible to ensure the energy efficiency potential is not double-counted, by over-stating the potential that could occur for end-uses where codes and standards are reducing baseline unit energy consumption. In addition, GDS has reflected the impacts of new EISA lighting standards that went into effect starting in 2012, as well as changes to other federal baseline standards across a variety of end uses. These adjustments reduce energy efficiency potential starting in the years these standards come into effect, and in subsequent years.

POTENTIAL SAVINGS OVERVIEW

Potential studies often distinguish between several types of energy efficiency potential: technical, economic, and achievable. However, because there are often important definitional issues between studies, it is important to understand the definition and scope of each potential estimate as it applies to this analysis.

Figure 5-1: Types of Energy Efficiency Potential[17]

Not Technically Feasable	Technical Potential		
Not Technically Feasable	Not Cost Effective	Economic Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential

The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings from energy efficiency measures. Still, even the best designed portfolio of programs is unlikely to capture 100 percent of the technical or economic potential. Therefore, achievable potential attempts to estimate what may realistically be achieved, when it can be captured, and how much it would cost to do so. Figure 5-1 above illustrates the three most common types of energy efficiency potential.

TECHNICAL POTENTIAL

The GDS Team has used the energy efficiency potential definitions included on page 2-4 of the November 2007 National Action Plan for Energy Efficiency (NAPEE) Guide for Conducting Energy

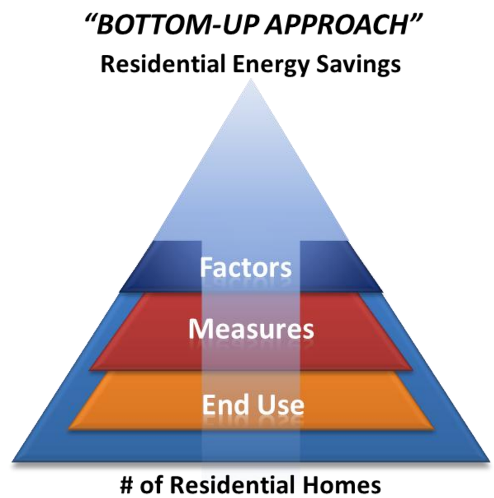
16 PUBLIC LAW 110–140—DEC. 19, 2007. Energy Independence and Security Act of 2007

17 Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

Efficiency Potential Studies. Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.[18]

In general, this study utilizes a "bottom-up" approach in the residential sector to calculate the potential of an energy efficiency measure or set of measures as illustrated in Figure 5-2 below. A bottom-up approach was used for the residential sector due to the amount of data available for this sector from DTE Energy and Consumers Energy, from Federal government surveys and research done in nearby states. A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its high efficiency counterpart, and then multiplies these values by the number of measures available to be installed throughout the life of the program. The bottom-up approach is applicable in the residential sector because of better secondary data availability and greater homogeneity of the building and equipment stock to which measures are applied, compared to the non-residential sector. However, this methodology was not utilized in the non-residential sector. For the non-residential sector, a "top-down" approach was used for developing the technical potential estimates. The "top down" approach builds an energy use profile based on estimates of kWh sales by business segment and end use. Savings factors for energy efficiency measures are then applied to applicable end use energy estimates after assumptions are made regarding the fraction of sales that are associated with inefficient equipment and the technical/engineering feasibility of each energy efficiency measure.

Figure 5-2: Residential Sector Savings Methodology - Bottom Up Approach



As shown in Figure 5-2, the methodology starts at the bottom based on the number of residential customers (splitting them into single-family, multi-family and manufactured housing types as well as existing homes vs. new construction). From that point, estimates of the size of the eligible market in Michigan were developed for each energy efficiency measure. For example, energy efficiency measures that affect electric space heating are only applicable to those homes in Michigan that have electric space heating.

As noted previously, to obtain up-to-date appliance and end-use saturation data, the study made extensive use of the energy efficiency baseline studies provided by the MPSC, DTE Energy and Consumers Energy. The study relied primarily on the statewide baseline studies completed by Cadmus in

[18] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies", page 2-4

2011 for the commercial and residential sectors. The DTE and Consumers Energy baseline studies for the residential sector were used in a few instances because the utility baseline studies contained some details lacking in the statewide residential study. The surveys collected detailed data on the current saturation of electricity and natural gas consuming equipment in the DTE Energy and Consumers Energy service areas and the energy efficiency level of HVAC equipment, appliances, and building shell characteristics. Estimates of energy efficient equipment saturations were based on several sources, including data collected from the 2009 RECS and the baseline studies provided by the Michigan utilities.

The goal of the approach is to determine how many households that a specific measure applies to (base case factor), then of that group, the fraction of households/buildings which do not have the energy efficient version of the measure being installed (remaining factor). In instances where technical reasons do not permit the installation of the efficient equipment in all eligible households an applicability factor is used to limit the potential. Alternative water heating technologies (efficient water heater tanks, heat pump water heaters or solar water heating systems) are then utilized to meet the remaining market potential. The last factor to be applied is the savings factor, which is the percentage savings achieved from installing the efficient measure over a standard measure.

In developing the overall potential electricity savings, the analysis accounts for the interactive effects of measures designed to impact the same end-use. For instance, if a home were to properly seal all ductwork, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from a heating/cooling equipment upgrade would be reduced. In instances where there are two (or more) competing technologies for the same electrical (or natural gas) end use, such as heat pump water heaters, water heater efficiency measures and high-efficiency electric storage water heaters, in most cases an equal percentage of the available population is assigned to each measure using the applicability factor[19]. In the event that one of the competing measures is not found to be cost-effective, the homes/buildings assigned to that measure are transitioned over any of the remaining cost effective alternatives.

The savings estimates per base unit are determined by comparing the high-efficiency equipment to current installed equipment for existing construction retrofits or to current equipment code standards for replace-on-burnout and new construction scenarios.

CORE EQUATION FOR THE RESIDENTIAL SECTOR

The core equation used in the residential sector energy efficiency technical potential analysis for each individual efficiency measure is shown below in Equation 5-1 below.

Equation 5-1: Core Equation for Residential Sector Technical Potential

$$\text{Technical Potential of Efficient Measure} = \text{Total Number of Households} \times \text{Base Case Equipment End Use Intensity} \times \text{Saturation Share} \times \text{Applicability Factor} \times \text{Savings Factor}$$

Where:

- **Total Number of Households** = the number of households in the market segment (e.g. the number of households living in detached single-family buildings)

[19] GDS used its professional judgment in some cases to assign unequal applicability factors to attempt to avoid overstating or understating the potential of the set of competing technologies.

- **Base Case Equipment End-use Intensity** = annual energy consumption (kWh or MMBtu) used per customer, per year, by each base-case technology in each market segment. This is the consumption of energy using equipment that efficient technology replaces or affects. This variable fully accounts for any known building characteristics in the service area, such as average square footage of homes in Michigan.
- **Saturation Share** = this variable has two parts: the first is the fraction of the end use energy that is applicable for the efficient technology in a given market segment. For example, for natural gas residential water heating, this would be the fraction of all residential gas customers that have gas water heating in their household; the second is the share of the end use gas energy that is applicable for the efficient technology that has not yet been converted to an efficient technology.
- **Applicability Factor** = this factor ensures that a household cannot receive two of the same type of measure. For example, if we assume there are two tiers of efficient natural gas furnaces, one which yields 10% savings and another which yields 20% savings, a household that needs to replace its inefficient natural gas furnace could either receive the unit which yields 10% savings or the unit which yields 20% savings, but could not receive both units. In general, GDS applies an even distribution to the same type of measure across eligible households when applying this factor. GDS may, in some cases, assign unbalanced applicability factors, if it believes an even distribution is inappropriate[20]. The applicability factor also captures the fraction of applicable units technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to add wall insulation in all homes because the original construction of some homes does not allow for wall insulation to be installed without requiring major reconstruction of the house, which would be an additional cost that does not yield any energy benefits).
- **Savings Factor** = the percentage of energy consumption reduction resulting from application of the efficient technology. The savings factor is a general term used to illustrate the calculation of a measure's technical potential. The Excel-based model GDS uses fully integrates the necessary assumptions to determine the measure-level savings, given the **Base Case Equipment End-use Intensity**, and the expected savings of each technology.

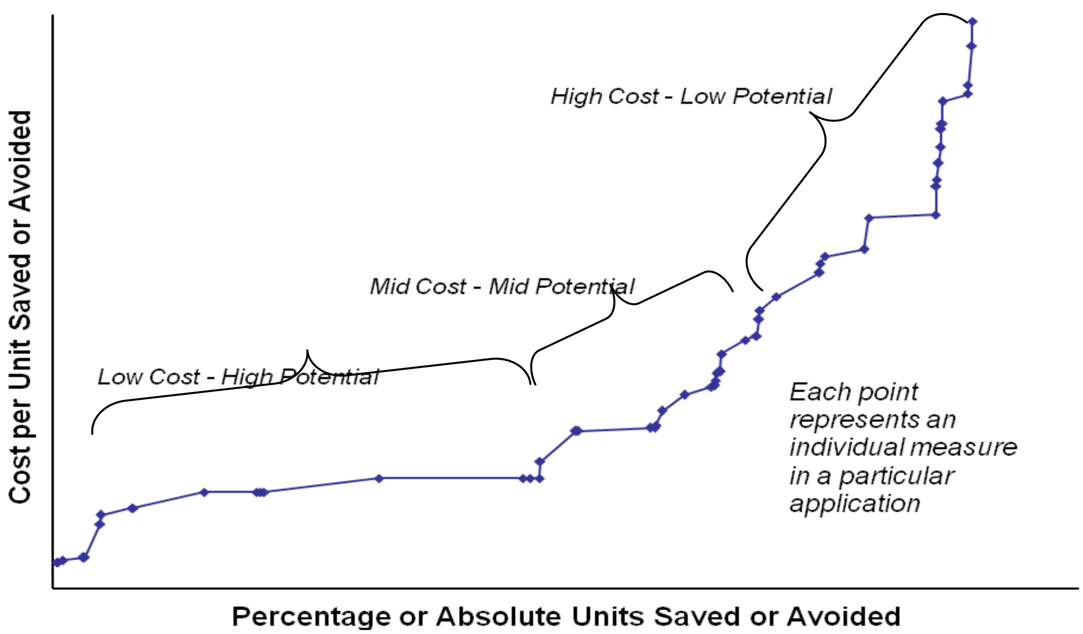
Technical energy efficiency potential in the residential sector is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or interacting measures. By analyzing measures independently, no assumptions are made about the combinations or order in which they might be installed in customer buildings. However, the cumulative technical potential cannot be estimated by adding the savings from the individual savings estimates because some savings would be double-counted. For example, the savings from a measure that reduces heat loss from a building, such as insulation, are partially dependent on other measures that affect the efficiency of the system being used to heat the building, such as a high-efficiency furnace; the more efficient the furnace, the less energy saved from the installation of the insulation. In the second step, adjustments are made to account for such interactive effects. The adjustments for interactive effects were made by upgrading the baseline conditions while holding the savings percentages constant. The upgraded baseline conditions vary by measure and assume some measures (such as weatherization measures) are installed to increase the building efficiency prior to the installation of the measure that is subject to the baseline adjustment (ex. high efficiency furnaces).

Finally, the GDS Team has developed a supply curve to show the amount of energy efficiency savings available at different cost levels. The residential sector supply curve is included in an appendix of this report. A generic example of a supply curve is shown in Figure 5-3. As shown in the figure, a supply curve typically consists of two axes; one that captures the cost per unit of saving a resource (e.g., dollars

[20] For example, if historical data indicates a technology has been able to garner a large share of the market GDS may assign a higher applicability factor to this technology in order to properly reflect this knowledge.

per lifetime kWh or MMBtu saved) and another that shows the amount of savings that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings measures are sorted based on a metric of cost. Total savings available at various levels of cost are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., costs increase rapidly and savings decrease significantly at the end of the curve.

Figure 5-3: Generic Example of a Supply Curve



As noted above, the cost portion of this energy efficiency supply curve is represented in dollars per unit of lifetime energy savings. Costs are annualized (often referred to as levelized) in supply curves. For example, electric energy efficiency supply curves usually present levelized costs per lifetime kWh saved by multiplying the initial investment in an efficient technology or program by the capital recovery rate (CRR), and then dividing that amount by annual kWh savings:

Therefore,

Levelized Cost per lifetime kWh Saved = Initial Cost x CRR/Annual kWh Savings

CORE EQUATION FOR THE COMMERCIAL SECTOR

The core equation utilized in the commercial sector technical potential analysis for each individual efficiency measure is shown below in Equation 5-2.

Equation 5-2: Core Equation for Commercial Sector Technical Potential

Where:

- **Total end-use kWh or natural gas sales by commercial sector and by building type** = the forecasted electric or natural gas sales level for a given end use (e.g., space heating) in a commercial or industrial industry type (e.g., office buildings or fabricated metals).
- **Base Case factor** = the fraction of end-use energy applicable for the efficient technology in a given commercial sector type. For example, with fluorescent lighting, this would be the fraction of all lighting kWh in a given industry type that is associated with fluorescent fixtures.
- **Remaining factor** = the fraction of applicable kWh or natural gas sales associated with equipment not yet converted to the electric or natural gas energy efficiency measure; that is, one minus the fraction of the industry type with energy efficiency measures already installed.
- **Convertible factor** = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install variable-frequency drives (VFDs) on all motors.
- **Savings factor** = the fraction of electric or natural gas consumption reduced by application of the efficient technology.

For the commercial sector, the development of the energy efficiency technical potential estimate begins with a disaggregated energy sales forecast over the ten year forecast horizon (2013 to 2022). The commercial sector energy sales forecast is broken down by building type, then by electric or natural gas end use. Then a savings factor is applied to end use electricity or natural gas sales to determine the potential electricity or natural gas savings for each end use. The commercial sector, as defined in this analysis, is comprised of the following business segments:

- Warehouse
- Retail
- Grocery
- Office
- Lodging
- Healthcare
- Restaurant
- Institutional, including education
- Other

Similar to the residential sector, technical electric or natural gas energy efficiency savings potential in the commercial sector is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics are analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly because some savings would be double-counted. For example, the savings from a weatherization measure, such as low-e ENERGY STAR windows, are partially dependent on other measures that affect the efficiency of the system being used to cool or heat the building, such as high-efficiency space heating equipment or high-efficiency air conditioning systems; the more efficient the space heating equipment or electric air conditioner, the less energy saved from the installation of low-e ENERGY STAR windows. Accordingly, the second step is to rank the measures based on a metric of cost-effectiveness (using the Total Resource Cost test and Utility Cost Test cost effectiveness tests) and adjust savings for interactive effects so that total savings are calculated incrementally with respect to measures that precede them.

CORE EQUATION FOR THE INDUSTRIAL SECTOR

Estimating energy efficiency potential for the industrial sector can be more challenging than it is for the residential and commercial sectors because of the significant differences in the way energy is used across manufacturing industries (or market segments). How the auto industry uses energy is very different from how a plastics manufacturer does. Further, even within a particular industrial segment, energy use is influenced by the particular processes utilized, past investments in energy efficiency, the age of the facility, and the corporate operating philosophy.

Recognizing the variability of energy use across industry types and the significance of process energy use in the industrial sector, GDS employed a top-down approach that constructed an energy profile based on local economic data, national energy consumption surveys and any available Michigan studies related to industrial energy consumption.

INDUSTRIAL SECTOR SEGMENTATION & END USE BREAKDOWN

Estimates of energy efficiency potential were developed employing a top-down approach using economic data for key industrial segments (Primarily 3 digit NAICS codes) in Michigan to develop industry-specific energy use estimates based on national energy intensities for each industry. Value of shipments data for Michigan is available from the U.S. Census Bureau. This economic data was used in conjunction with energy use estimates from the 2010 Manufacturing Energy Consumption Survey[21] which is produced by the Energy Information Administration (EIA), to develop estimates of industrial electric and natural gas energy use by industry type and end use.

Industrial baseline energy consumption data was advanced to 2013 and future years based upon the observed historical trend in Michigan's industrial consumption and EIA's industrial electricity and natural gas consumption forecast for the U.S. (i.e., Annual Energy Outlook 2013).

End use electric and natural gas energy consumption estimates were calculated for the following end use categories for specific manufacturing segments:

- **Indirect Uses – Boilers**
  - Conventional boiler use
- **Direct Uses - Process**
  - Process heating (e.g., kilns, furnaces, ovens, strip heaters)
  - Process cooling & refrigeration
  - Machine drive
  - Electro-chemical processes
  - Other direct process use
- **Direct Uses – Non-process**
  - Facility heating, ventilation and air conditioning
  - Facility lighting
  - Other facility support (e.g., cooking, water heating, office equipment)
- **Other Non-process Use**

[21] http://www.eia.gov/emeu/mecs/contents.html

DEVELOPMENT OF POTENTIAL ESTIMATES

Estimates of industrial energy use by industry type and end use served as the foundation upon which energy efficiency potential estimates were calculated. The basic equation for determining technical potential is shown below.

The core equation for estimating technical potential in the industrial sector analysis for each measure is provided below:

Where:

- Total end-use sales by industry type = the forecasted electric or natural gas sales level for a given end use (e.g., space heating) by industrial industry type (e.g., fabricated metals, automobile manufacturing, paper and allied products, etc.).
- Base Case factor = the fraction of end-use energy applicable for the efficient technology in a given industry type. For example, with fluorescent lighting, this would be the fraction of all lighting kWh in a given industry type that is associated with fluorescent fixtures.
- Remaining factor = the fraction of applicable sales associated with equipment not yet converted to the electric energy-efficiency measure; that is, one minus the fraction of the industry type with energy-efficiency measures already installed.
- Convertible factor = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install variable-frequency drives (VFDs) on all motors.
- Savings factor = the fraction of energy consumption reduced by application of the efficient technology.

ECONOMIC POTENTIAL

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the cost effectiveness tests utilized for this Michigan study) as compared to conventional supply-side energy resources. GDS has calculated the benefit/cost ratios for this study according to the cost effectiveness test definitions provided in the November 2008 National Action Plan for Energy Efficiency (NAPEE) guide titled "Understanding Cost Effectiveness of Energy Efficiency Programs". Both technical and economic potential are theoretical numbers that assume immediate implementation of energy efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of energy efficiency. *Finally, they typically only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, program evaluation, etc.) that would be necessary to capture them.*

Furthermore, all measures that were not found to be cost-effective based on the results of the measure-level cost effectiveness screening were excluded from the economic and achievable potential. Then allocation factors were re-adjusted and applied to the remaining measures that were cost effective.

DETERMINING COST-EFFECTIVENESS

GDS Team examined measure cost effectiveness scenarios based on the Total Resource Cost (TRC) test and the Utility Cost Test.

Total Resource Cost Test[22]

The TRC measures the net benefits of the energy efficiency program for the region as a whole. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program, regardless of who pays these costs. The benefits included are the avoided costs of energy (as with the Utility Cost Test and the Rate Impact Measure Test) as well as non-energy benefits. GDS did include a benefit of $9.25 per ton of reduced carbon emission. This risk adjusted value represents the expected value of a scenario with no carbon taxes and a scenario with carbon taxes of $18.50 per ton.

The primary purpose of the TRC test is to evaluate the net benefits of energy efficiency measures to the region or State as a whole. Unlike the Utility Cost Test, the Rate Impact Measure (RIM) test or the Participant Cost Test (PCT), the TRC does not take the view of individual stakeholders. It does not include bill savings and incentive payments, as they yield an intra-regional transfer of zero ("benefits" to customers and "costs" to the utility that cancel each other on a regional level). For some utilities, the region considered may be limited strictly to its own service territory, ignoring benefits (and costs) to neighboring areas (a distribution-only utility may, for example, consider only the impacts to its distribution system). In other cases, the region is defined as the state as a whole, allowing the TRC to include benefits to other stakeholders (e.g., other utilities, water utilities, local communities). The TRC is useful for jurisdictions wishing to value energy efficiency as a resource not just for the utility, but for the entire region. Thus the TRC is the most frequently used primary test in the United States. The TRC may be considered the sum of the PCT and RIM, that is, the participant and non-participant cost-effectiveness tests. The TRC is also useful when energy efficiency might fall through the cracks taken from the perspective of individual stakeholders, but would yield benefits on a wider regional level

Utility Cost Test

The Utility Cost Test (UCT) examines the costs and benefits of an energy efficiency program from the perspective of the entity implementing the program (utility, government agency, nonprofit, or other third party). GDS set incentives at 50% of measure costs when calculating the UCT. When conducting screening at the measure level, GDS only included utility costs relating to the equipment cost. For program or portfolio screening, GDS included all costs incurred by the utility. Overhead costs include the utility's administration, marketing, research and development, evaluation, and measurement and verification costs. Incentive costs are payments made to the utility's customers to offset purchase or installations costs. The benefits from the utility perspective are the savings derived from not delivering the energy to customers. Depending on the jurisdiction and type of utility, the "avoided costs" can include avoided or reduced wholesale electricity or natural gas purchases, generation costs, power plant construction, transmission and distribution facilities, ancillary service and system operating costs, and other components.

[22] It is important to note that the Michigan PSC staff, GDS Associates and staff from DTE Energy and Consumers Energy decided not to include any unquantifiable non-energy benefits in the calculation of the TRC Test (beyond savings water, avoided carbon emissions, and O&M savings). While other non-energy benefits may be present, they have not been quantified in the state of Michigan and were not available for inclusion in this study.

Table 5.1 below shows the key assumptions used by GDS in the development of the economic and achievable potential estimates based upon cost effectiveness screening using the Total Resource Cost (TRC) test and the Utility Cost test (UCT):

Table 5.1: Key Assumptions Used by GDS in the Development of Measure-Level Screening

Key Assumption	Used in UCT Screening	Used in TRC Screening
Utility weighted average cost of capital for the discount rate	Yes	Yes
Forecasts of electric and natural gas energy and capacity avoided costs provided to GDS by the staff of the Michigan Public Service Commission	Yes	Yes
Forecast of electric T&D avoided costs per kW/year based on 2009 study by the New York Public Service Commission	Yes	Yes
Average line losses provided by Michigan utilities	Yes	Yes
MISO planning reserve margin	Yes	Yes
Electricity and natural gas savings benefits both valued in the cost effectiveness test for electric or natural gas energy efficiency programs	Yes	Yes
Value of avoided bulb purchases for high efficiency light bulbs	No	Yes
Water savings where applicable	No	Yes
Tax credits	No	Yes
Non-energy benefits (adder of $9.25 per ton of carbon emissions avoided)	No	Yes

ACHIEVABLE POTENTIAL

Achievable potential was determined as the amount of energy and demand that can realistically be saved assuming an aggressive program marketing strategy and with three scenarios. Achievable potential takes into account barriers that hinder consumer adoption of energy efficiency measures such as financial, political and regulatory barriers, and the capability of programs and administrators to ramp up activity over time. This potential study evaluates three achievable potential scenarios:

1) **Scenario #1**: For the first scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 50% of the incremental measure cost and no spending cap. Cost effectiveness of measures was determined with the Utility Cost Test. The long-term market penetration for Scenario #1 was estimated based on the utilities paying incentives equal to 50% of measure costs. Year-by-year estimates of achievable potential for the period 2014 to 2023 were estimated by applying market penetration curves to this long-term penetration rate estimate. In general, these curves were developed based on willingness to pay data collected through survey research. Although this simplifies what an adoption curve would look like in practice, it succeeds in providing a concise method for estimating achievable savings potential over a specified period of time.

2) **Scenario #2**: For the second scenario, achievable potential is based on measure cost effectiveness screening using the Total Resource Cost Test with utility incentives again equal to 50% of measure costs. GDS calculated the savings and costs associated with the 50% incentive

level. Year-by-year estimates of achievable potential for the period 2014 to 2023 were estimated by applying market penetration curves to this long-term penetration rate estimate. Any differences between Achievable Scenario #1 and Achievable Scenario #2 result from the varied measures that pass the Utility Cost Test compared to the Total Resource Cost Test

3) **Scenario #3**: The third scenario is a subset of Achievable Scenario #1(based on UCT). While scenario #1 assumed no spending cap on efficiency measures, Achievable Scenario #3 assumed a spending cap of approximately 2% of utility revenues. Revenues are apportioned across each customer sector to prevent cross-subsidization of energy efficiency savings. GDS has not attempted to define specific program plans. Instead the market adoption assumptions from Achievable Scenario #1 have been scaled down to fit within the spending parameters.

While many different incentive scenarios could be modeled, the number of achievable potential scenarios that could be developed was limited to three scenarios due to the available budget for this potential study[23]. The penetration curves are based on an expected market adoption given the assumed level of incentives. For the residential sector, GDS estimated the market adoption using the results of a survey of multifamily building property managers which ascertained the property managers' willingness to participate in hypothetical energy efficiency programs at given levels of incentives for a variety of end use measures[24]. GDS chose to use this approach in order to use the results of actual survey data and to differentiate the anticipated market adoption across measures and end-uses, in lieu of assuming a universal market adoption rate across all measures or groups of measures, which would be based solely on professional judgment. The chosen approach provides real data in conjunction with professional judgment, which was used to verify the reasonableness of the assumed market adoption rates across the various end uses. For the non-residential sector, GDS used a similar approach based on data collected from surveys of businesses in the state of Maine. These three achievable potential scenarios contain uncertainty based on consumer's actual willingness to participate in programs offered by utilities in Michigan.

For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction. For existing buildings, determining the annual rate of availability of savings is more complex. Energy efficiency potential in the existing stock of buildings can be captured over time through three principal processes:

1) As equipment replacements are made normally in the market when a piece of equipment is at the end of its effective useful life (referred to as "replace-on-burnout")
2) At any time in the life of the equipment or building (referred to as "retrofit")
3) When a new home or building is constructed

For the replace-on-burnout measures, existing equipment is assumed to be replaced with high-efficiency equipment at the time a consumer is shopping for a new appliance or other energy consuming equipment, or if the consumer is in the process of building or remodeling. Using this approach, only equipment that needs to be replaced in a given year is eligible to be upgraded to energy efficient equipment. For the retrofit measures, savings can theoretically be captured at any time; however, in practice, it takes many years to retrofit an entire stock of buildings, even with the most aggressive of energy efficiency programs. For new construction, savings are achieved at the time the building is completed.

[23] None of the three scenarios is considered a "maximum" achievable scenario. Maximum achievable scenarios assume 100% incentives. The three scenarios included in the report assume 50% incentives. This approach approximates the level incentives currently offered by Michigan utilities.

[24] Massachusetts Multifamily Market Characterization and Potential Study Volume 1, May 2012. The Cadmus Group, et al.

6 RESIDENTIAL ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides electric and natural gas energy efficiency potential estimates for the residential sector in Michigan which includes all residential buildings. Estimates of technical, economic and achievable potential are provided. Electric and natural gas potential are presented as separate sections, but interactive effects and measures that yield both electric and natural gas savings are fully accounted for in the analysis.

6.1 RESIDENTIAL ELECTRIC POTENTIAL

According to 2011 historical sales data, the residential sector accounts for approximately 89% of total customers and 33% of total energy sales. The average residential consumer uses approximately 7,900 kWh per year. From 2002-2011, the residential sector sales and customers have experienced minimal growth. This analysis assumes residential MWh sales increase at roughly 0.25% annually based upon the based on Michigan utility load forecasts. The residential electric potential calculations are based upon these approximate consumption values and sales forecast figures over the time horizon covered by the study. The potential is calculated for the entire residential sector and includes breakdowns of the potential associated with each end use.

6.1.1 Energy Efficiency Measures Examined

For the residential sector, there were 1108 total electric savings measures included in the potential energy savings analysis[25]. Table 6-1 provides a brief description of the types of measures included for each end use in the residential model. The list of measures was developed based on a review of the Michigan Energy Measure Database (MEMD) and measures found in other residential potential studies and TRMs from the Midwest. Measure data includes incremental costs, electricity energy and demand savings, gas and water savings, and measure life.

Table 6-1: Measures and Programs Included in the Electric Residential Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
HVAC Envelope	Building Envelope Upgrades	• Air/duct Sealing • Duct Insulation • Improved Insulation (Wall, Ceiling, and Floor) • Efficient Windows • Window Film • ENERGY STAR Doors • Cool Roofs • Low Income Weatherization Package
HVAC Equipment	Heating/Cooling/Ventilation Equipment	• Existing Central AC Tune-Up • Efficient Air-Source Heat Pump • Dual Fuel Heat Pumps • Geothermal Heat Pumps • Ductless Mini-split Systems

[25] This total represents the number of unique electric energy efficiency measures and all permutations of these unique measures. For example, there are 76 permutations of the "Improved Duct Sealing" measure to account for the various housing types, heating/cooling combinations, and construction types.

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		• Efficient Central AC Systems • Programmable Thermostats • Efficient Room Air Conditioners • Room Air Conditioner Recycling • Whole House Fans • Efficient Chillers • Chiller Controls • Efficient Furnace Fans
Water Heating	Domestic Hot Water	• Heat Pump Water Heater • Solar Water Heater • Low Flow Showerhead/Faucet Aerator • Gravity Film Heat Exchangers • Pipe Wrap • Tank Wrap
Lighting	Interior/Exterior Lighting	• Specialty CFLs • Standard CFLs • LED Lighting • Efficient Exterior Lighting • Efficient Torchiere Lamps • Efficient Fluorescent Tube Lighting • LED Night Lights • Occupancy Sensors • Holiday Lighting • Efficient Multifamily Common Area Lighting
Appliances	High-Efficiency Appliances / Retirement of Inefficient Appliances	• ENERGY STAR Clothes Washers • ENERGY STAR Refrigerator • ENERGY STAR Freezers • ENERGY STAR Dishwashers • ENERGY STAR Dehumidifiers • Heat Pump Dryers • Secondary Refrigerator/Freezer Turn-In • 2nd Dehumidifier Turn-In
Electronics	High Efficiency Consumer Electronics	• Controlled Power Strips • Efficient Set-Top Boxes • ENERGY STAR Desktops • Efficient Laptops • Efficient Televisions • LCD Monitors
Behavioral	Consumer Response to Feedback from Utility	• Direct (Real-Time) Feedback • Indirect Feedback
Other	Efficient Pool Equipment	• Efficient Pool Pump Motors

6.1.2 Overview of Residential Electric Energy Efficiency Potential

This section presents estimates for electric technical, economic, and achievable potential for the residential sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative energy savings (MWh), percentage of savings by end use, and savings as a percentage of forecast sales. Data is provided on a 5-year and 10-year time horizon for Michigan.

This energy efficiency potential study considers the impacts of the Energy and Independence and Security Act (EISA) as an improving code standard for the residential sector. The EISA improves the baseline efficiency of several types of lighting products, including CFL or LED bulbs. Other known increases to federal minimum efficiency standards over the time period studied have also been accounted for in the analysis. These included changes to the efficiency standards central air conditioners, electric water heaters, and appliances.

There are a variety of factors which contribute to uncertainty surrounding the savings estimates produced by this energy efficiency potential study. These factors can include the following:

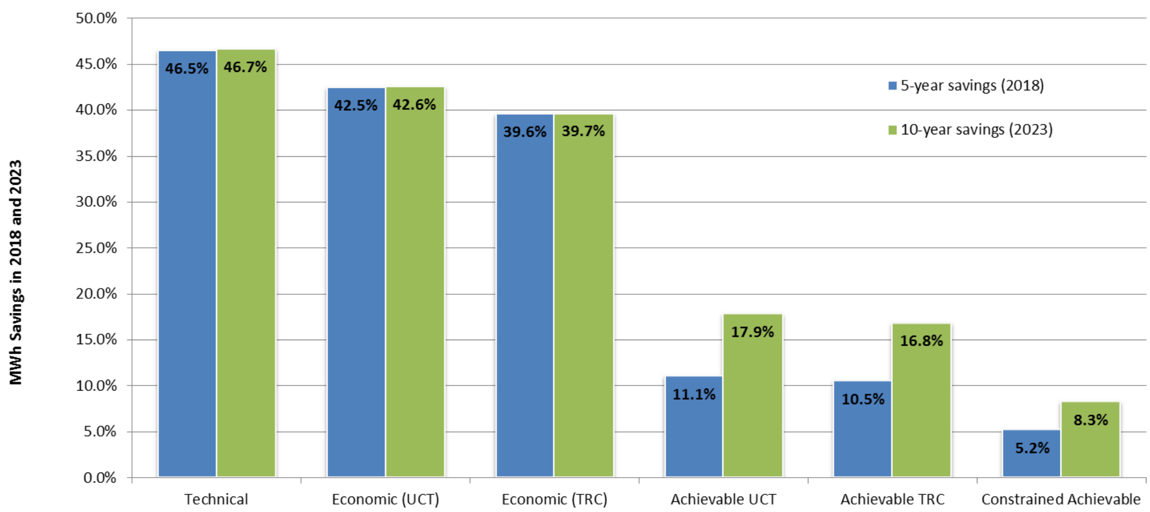
- Uncertainty about economic and fuel price forecasts used as inputs to the electric and natural gas sales forecasts
- The accuracy of results generated by building energy simulation modeling software
- The lack of availability of up-to-date efficiency saturation data for Michigan
- Changes to codes and standards in the future which cannot be anticipated at the present time, and
- Uncertainty regarding the future adoption of energy efficiency technologies which have minimal market share at the present time, such as LED lighting.

GDS has addressed the areas of uncertainty as robustly as possible given the time and budget constraints of this project. For example, GDS assumes increasing market adoption of LEDs over the life of the study because LED costs are expected to decrease over time. GDS also assimilated baseline study data into the estimates of weather sensitive measure savings where possible to adjust values acquired from the MEMD. These adjustments apply to measures such as insulation, for which savings are provided on a square footage basis in the MEMD. Weather-sensitive measure savings estimates from the MEMD were also adjusted to account for known changes to federal standards.

SUMMARY OF FINDINGS

Figure 6-1 illustrates the estimated savings potential for each of the scenarios included in this study.

Figure 6-1: Summary of Residential Electric Energy Efficiency Potential as a % of 2018 and 2023 Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 sector sales. The technical potential is 46.5% in 2018 and 46.7% in 2023. The 5-year and 10-year economic potential is 42.5% and 42.6% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 39.6% in 2018 and 39.7% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective, particularly when screening based on the UCT.

The 5-year and 10-year achievable potential savings are: 11.1% and 17.9% for the Achievable UCT scenario; 10.5% and 16.8% for the Achievable TRC scenario; and 5.2% and 8.3% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on DSM approximately equal to 2% of future annual residential revenue from electric and gas retail sales.

TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if all technologically available energy-efficiency measures are immediately adopted in all feasible instances, regardless of cost. Table 6-2 shows that it is technically feasible to save more than 15.7 million MWh in the residential sector between 2014 to 2018, as well as approximately 16.1 million MWh during the 10 year period from 2014 to 2023 statewide, representing 46.5% of 5-year residential sales, and 46.7% of 10-year residential sales.[26] Lighting represents the greatest contributor to the potential at 42% of savings, while Appliances, Electronics, and HVAC Equipment end uses each contribute 10-19% of the savings. Table 6-3 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 4,482 MW and 4,582 MW, respectively, which is 44.8% and 45.8% of the peak forecast.

[26] Technical potential represents the potential for all inefficient measures to be implemented "over-night." The only growth in potential over the 5 and 10 year time period is related to new construction.

Table 6-2: Residential Sector Technical Potential Energy Savings by End Use

End Use	2018 Energy (MWh)	% of 2018 Savings	2023 Energy (MWh)	% of 2023 Savings
Appliances	1,917,176	12%	1,932,681	12%
Electronics	1,577,777	10%	1,616,476	10%
Lighting	6,635,212	42%	6,798,910	42%
Water Heating	1,328,123	8%	1,371,227	9%
Other	178,956	1%	182,695	1%
HVAC (Envelope)	688,052	4%	714,653	4%
HVAC (Equipment)	2,920,976	19%	2,993,190	19%
Behavioral Programs	483,616	3%	494,242	3%
Total	**15,729,887**	**100%**	**16,104,075**	**100%**
% of Annual Sales Forecast	*46.5%*		*46.7%*	

Table 6-3: Residential Sector Technical Potential Demand Savings

	Summer Peak Demand	
	2018	**2023**
Summer	**MW**	**MW**
Total	**4,482**	**4,582**
% of Peak	*44.8%*	*44.8%*

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. Because the TRC includes participant costs, it goes beyond utility resource acquisition and looks at the measure/program from a more broad perspective. 79% of all measures that were included in the electric potential analysis passed the UCT and 69% of all measures passed the TRC Test.

Table 6-4 indicates that the economic potential based on the UCT screen is nearly 14.4 million MWh during the 5 year period from 2014 to 2018, and the economic potential increases nearly 14.7 million MWh during the 10 year period from 2014 to 2023. This represents 42.5% and 42.6% of residential sales across the respective 5-year and 10-year timeframes. Similar to the technical potential scenario, lighting represents the greatest contributor to the potential at 43% of savings, while the HVAC Equipment, appliances, electronics, and water heating end uses each contribute between 11-18% of the savings. Table 6-5 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 4,099 MW and 4,191 MW, respectively, which is 40.9% and 41.9% of the peak forecast.

Table 6-4: Residential Sector Economic Potential (UCT) Energy Savings by End Use

End Use	2018 Energy (MWh)	% of 2018 Savings	2023 Energy (MWh)	% of 2023 Savings
Appliances	1,788,370	12%	1,797,933	12%
Electronics	1,511,111	11%	1,548,722	11%
Lighting	6,147,059	43%	6,299,906	43%

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Water Heating	1,324,484	9%	1,368,559	9%
Other	178,956	1%	182,695	1%
HVAC (Envelope)	403,357	3%	416,069	3%
HVAC (Equipment)	2,519,726	18%	2,583,665	18%
Behavioral Programs	483,616	3%	494,242	3%
Total	**14,356,678**	**100%**	**14,691,791**	**100%**
% of Annual Sales Forecast	*42.5%*		*42.6%*	

Table 6-5: Residential Sector Economic Potential (UCT) Demand Savings

SUMMER PEAK DEMAND		
	2018	**2023**
Summary	**MW**	**MW**
Total	**4,099**	**4,191**
% of Peak	*40.9%*	*41.0%*

Table 6-6 demonstrates that the economic potential based on the TRC screen is lower than the economic potential based on the UCT screen. In 2023, economic potential based on the TRC cost-effectiveness screening is approximately 1 million kWh lower than the economic potential based on the UCT. The biggest decline in economic potential between the two screens occurred in the HVAC (Equipment) end-use where measure costs are high and incentive amounts can significantly impact cost-effectiveness.

Table 6-6: Residential Sector Economic Potential (TRC) Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	1,788,370	13%	1,797,933	13%
Electronics	1,511,111	11%	1,548,722	11%
Lighting	6,147,059	46%	6,299,906	46%
Water Heating	1,324,484	10%	1,368,559	10%
Other	178,956	1%	182,695	1%
HVAC (Envelope)	339,743	3%	349,597	3%
HVAC (Equipment)	1,614,611	12%	1,646,459	12%
Behavioral Programs	483,616	4%	494,242	4%
Total	**13,387,948**	**100%**	**13,688,112**	**100%**
% of Annual Sales Forecast	*39.6%*		*39.7%*	

Table 6-7: Residential Sector Economic Potential (TRC) Demand Savings

SUMMER PEAK DEMAND		
	2018	**2023**
Summary	**MW**	**MW**
Total	**3,965**	**4,056**
% of Peak	*39.6%*	*39.7%*

6.1.1 Achievable Electric Potential Savings in the Residential Sector

Achievable potential is a refinement of economic potential that takes into account the estimated market adoption of energy efficiency measures based on the incentive level and measure payback, the natural replacement cycle of equipment, and the capabilities of programs and administrators to ramp up program activity over time. Achievable potential also takes into account the non-measure costs of delivering programs (for administration, marketing, monitoring and evaluation, etc.). For purposes of this analysis, administrative costs were assumed to be equivalent to 20% of incremental measures costs. This is based on a published review of typical program administrator costs of several utility energy efficiency programs nationwide.[27]

This study estimated achievable potential for three scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost.[28] The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

6.1.1.1 Achievable UCT vs. Achievable TRC

Tables 6-8 through Table 6-11 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is more than 350,000 MWh greater, over the next decade, than the achievable TRC scenario.

Table 6-8: Residential Achievable UCT Potential Electric Energy Savings by End Use

End Use	2018 Energy (MWh)	% of 2018 Savings	2023 Energy (MWh)	% of 2023 Savings
Appliances	557,903	15%	1,015,938	16%
Electronics	809,212	22%	1,019,376	17%
Lighting	1,224,816	33%	2,133,468	35%
Water Heating	236,600	6%	551,401	9%
Other	41,170	1%	93,233	2%
HVAC (Envelope)	134,543	4%	272,416	4%
HVAC (Equipment)	357,362	10%	698,213	11%
Behavioral Programs	375,625	10%	376,659	6%
Total	**3,737,232**	100%	**6,160,705**	**100%**
% of Annual Sales Forecast	*11.1%*		*17.9%*	

Table 6-9: Residential Achievable UCT Potential Demand Savings

Summer Peak Demand		
	2018	**2023**
Summary	**MW**	**MW**
Total	**846**	**1,434**
% of Peak	*8.5%*	*14.0%*

[27] PacifiCorp Assessment of Long-Term, System-Wide Potential for Demand-Side and Other Supplemental Resources. Volume II. Prepared by Cadmus. March 2013. Appendix B-4.

[28] Traditional low income measures associated with Michigan's Weatherization Assistance Program were evaluated using 100% incentives across all three achievable potential scenarios. All other measures were evaluated at the 50% incentive level.

Table 6-10: Residential Achievable TRC Potential Electric Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
Appliances	557,903	16%	1,015,938	17%
Electronics	809,212	23%	1,019,376	18%
Lighting	1,224,816	34%	2,133,468	37%
Water Heating	236,600	7%	551,401	9%
Other	41,170	1%	93,233	2%
HVAC (Envelope)	115,483	3%	234,236	4%
HVAC (Equipment)	198,917	6%	386,888	7%
Behavioral Programs	375,625	11%	376,659	6%
Total	**3,559,727**	**100%**	**5,811,199**	**100%**
% of Annual Sales Forecast	*10.5%*		*16.8%*	

Table 6-11: Residential Achievable TRC Potential Demand Savings

SUMMER PEAK DEMAND		
	2018	**2023**
Summary	**MW**	**MW**
Total	**821**	**1,400**
% of Peak	*8.2%*	*13.7%*

The 5-year and 10-year Achievable UCT potential savings estimates are approximately 3.7 million MWh and 6.2 million MWh. This equates to 11.1% and 17.9% of sector sales in 2018 and 2023. By comparison, the respective 5-year and 10-year Achievable TRC potential savings estimates are approximately 3.6 million MWh and 5.8 million MWh. This equates to 10.5% and 16.8% of sector sales in 2018 and 2023. The five and ten year demand savings estimates in the Achievable UCT and Achievable TRC scenarios are depicted in Tables 6-9 and 6-11, respectively.

6.1.1.1 Achievable UCT vs. Constrained UCT

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of Michigan utility revenue.

Table 6-12 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizon. The 5-year and 10-year Achievable UCT potential savings estimates are approximately 1.8 million MWh and 2.9 million MWh. This equates to 5.2% and 8.3% of sector sales in 2018 and 2023. The five and ten year demand savings estimates in the Constrained UCT scenario are depicted in Table 6-13.

Table 6-12: Residential Constrained Achievable Savings Potential Energy Savings by End Use

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
End Use	**Energy (MWh)**	**Savings**	**Energy (MWh)**	**Savings**
Appliances	262,011	15%	467,610	16.4%
Electronics	378,888	22%	469,038	16.4%
Lighting	576,536	33%	988,336	34.7%
Water Heating	111,589	6%	256,500	9.0%
Other	19,412	1%	43,384	1.5%
HVAC (Envelope)	63,768	4%	127,243	4.5%

END USE	2018 ENERGY (MWH)	% OF 2018 SAVINGS	2023 ENERGY (MWH)	% OF 2023 SAVINGS
HVAC (Equipment)	169,000	10%	324,823	11.4%
Behavioral Programs	171,675	10%	174,668	6.1%
Total	**1,752,880**	**100%**	**2,851,602**	**100.0%**
% of Annual Sales Forecast	*5.2%*		*8.3%*	

Table 6-13: Residential Constrained Achievable Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**398**	**665**
% of Peak	*4.0%*	*6.5%*

Figure 6-2 shows the percentage of electric savings by each end use for the Constrained UCT scenario. The lighting end use shows the largest potential for savings with nearly 35% of total electric savings, followed by the appliances and electronics end uses at 16% of total savings each.

Figure 6-2: Residential Sector 2023 Constrained UCT Electric Potential Savings, by End Use

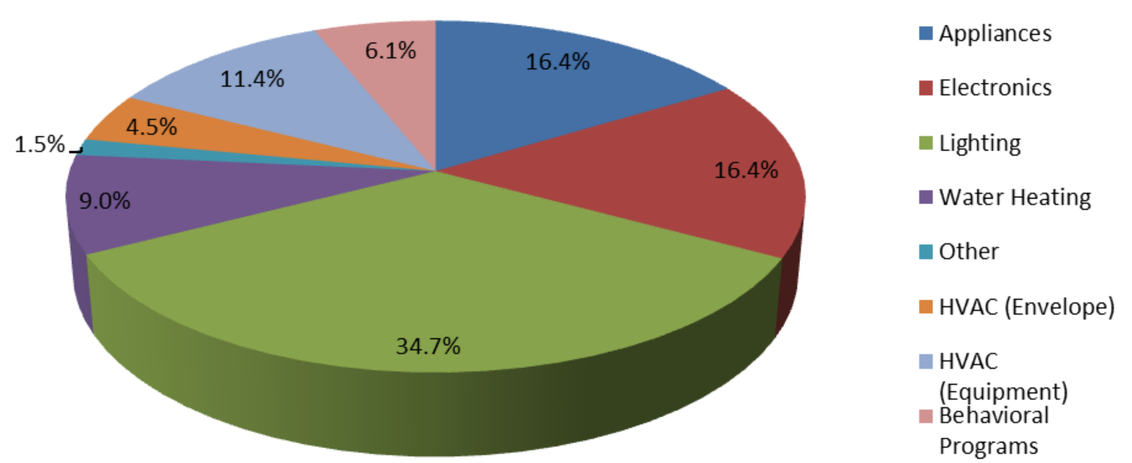
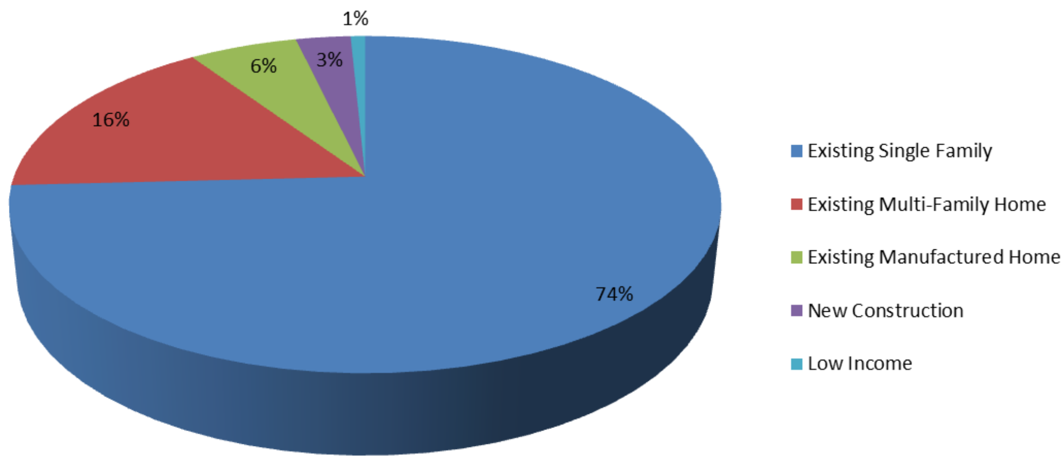


Figure 6-3 shows the breakdown of estimated savings in 2023 by housing type, low-income designation and new construction measures, for the Achievable UCT potential scenario. The savings are largely coming from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed. The existing single-family housing and existing multi-family housing types lead the way with 74% of savings and 16% savings, respectively, followed by and 6% coming from existing manufactured homes. New construction measures account for 3% of total savings and low-income measures account for 1% of total savings. The low-income measures represent only those measures typically included in the Michigan Weatherization Assistance Program to low-income households, and do not represent the combined "low-income potential" in Michigan. There is also low-income potential that is subsumed by the other 99% of the savings associated with the "non-low-income" measures. For example, low income households could realize additional LED lighting and/or behavioral program energy efficiency savings, even though they may not be offered under the traditional umbrella of low-income programs.

Figure 6-3: Residential Constrained Achievable Savings in 2023, by Housing Type, Low-Income Designation and New Construction Measures



6.1.2 Annual Achievable Electric Savings Potential

Table 6-14, Table 6-15 and Table 6-16 shows cumulative annual energy savings for all three achievable potential scenarios for each year across the 10-year time horizon for the study, broken out by end use. The year by year associated incentive and administrative costs to achieve these savings are shown later, in Section 6.3.

Table 6-14: Cumulative Annual Residential Energy Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	63,204	184,778	308,064	432,402	557,903	683,467	809,066	934,694	1,003,654	1,015,938
Electronics	108,356	258,397	450,588	643,188	809,212	932,395	988,648	1,015,889	1,017,751	1,019,376
Lighting	188,461	425,978	698,138	963,094	1,224,816	1,479,827	1,726,250	1,901,248	2,067,962	2,133,468
Water Heating	38,480	81,888	129,819	181,234	236,600	295,502	357,087	421,682	486,410	551,401
Other	6,666	14,104	22,333	31,341	41,170	51,244	61,551	72,090	82,651	93,233
HVAC (Envelope)	26,497	53,170	80,100	107,185	134,543	161,998	189,521	217,100	244,734	272,416
HVAC (Equipment)	64,956	133,175	204,621	279,366	357,362	427,818	498,274	568,730	637,964	698,213
Behavioral Programs	92,972	193,042	313,696	354,760	375,625	375,955	376,224	376,363	376,509	376,659
Total	**589,594**	**1,344,533**	**2,207,359**	**2,992,569**	**3,737,232**	**4,408,206**	**5,006,620**	**5,507,797**	**5,917,636**	**6,160,705**
% of Annual Forecast Sales	*1.7%*	*4.0%*	*6.5%*	*8.9%*	*11.1%*	*13.0%*	*14.7%*	*16.1%*	*17.2%*	*17.9%*

Table 6-15: Cumulative Annual Residential Energy Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	63,204	184,778	308,064	432,402	557,903	683,467	809,066	934,694	1,003,654	1,015,938
Electronics	108,356	258,397	450,588	643,188	809,212	932,395	988,648	1,015,889	1,017,751	1,019,376
Lighting	188,461	425,978	698,138	963,094	1,224,816	1,479,827	1,726,250	1,901,248	2,067,962	2,133,468
Water Heating	38,480	81,888	129,819	181,234	236,600	295,502	357,087	421,682	486,410	551,401
Other	6,666	14,104	22,333	31,341	41,170	51,244	61,551	72,090	82,651	93,233
HVAC (Envelope)	22,695	45,563	68,682	91,953	115,483	139,110	162,810	186,570	210,381	234,236
HVAC (Equipment)	33,337	69,969	109,782	152,829	198,917	238,615	277,864	316,657	353,709	386,888
Behavioral Programs	92,972	193,042	313,696	354,760	375,625	375,955	376,224	376,363	376,509	376,659
Total	**554,172**	**1,273,720**	**2,101,102**	**2,850,800**	**3,559,727**	**4,196,115**	**4,759,499**	**5,225,194**	**5,599,027**	**5,811,199**
% of Annual Forecast Sales	*1.6%*	*3.8%*	*6.2%*	*8.4%*	*10.5%*	*12.4%*	*14.0%*	*15.3%*	*16.3%*	*16.8%*

Table 6-16: Cumulative Annual Residential Energy Savings in the Constrained UCT Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	32,567	90,848	147,638	204,893	262,011	319,179	376,578	434,603	463,615	467,610
Electronics	55,832	127,760	216,290	304,978	378,888	432,177	453,983	465,366	467,057	469,038
Lighting	97,108	210,971	335,741	457,502	576,536	692,561	805,204	886,132	963,095	988,336
Water Heating	19,828	40,637	62,715	86,391	111,589	138,407	166,506	196,320	226,317	256,500
Other	3,435	7,001	10,791	14,939	19,412	23,999	28,709	33,577	38,471	43,384
HVAC (Envelope)	13,653	26,440	38,845	51,317	63,768	76,268	88,845	101,584	114,389	127,243
HVAC (Equipment)	33,470	66,173	99,084	133,502	169,000	200,593	232,600	265,153	297,186	324,823
Behavioral Programs	47,905	93,451	146,740	164,234	171,675	171,501	171,695	173,071	173,944	174,668
Total	**303,798**	**663,280**	**1,057,844**	**1,417,755**	**1,752,880**	**2,054,684**	**2,324,120**	**2,555,805**	**2,744,074**	**2,851,602**
% of Annual Forecast Sales	*0.9%*	*2.0%*	*3.1%*	*4.2%*	*5.2%*	*6.1%*	*6.8%*	*7.5%*	*8.0%*	*8.3%*

6.1.3 Residential Electric Savings Summary by Measure Group

Table 6-17 provides an end-use breakdown of the residential electric savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained UCT potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 6-17: Breakdown of Residential Cumulative Annual Electric Savings Potential for Technical, Economic and Achievable Potential, by End Use for Michigan.

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE –UCT- (MWH)
Appliances						
ENERGY STAR Refrigerators	177,240	177,240	177,240	34,064	34,064	15,792
ENERGY STAR Freezers	68,256	68,256	68,256	19,781	19,781	9,167
ENERGY STAR Clothes Washers	36,910	0	0	0	0	0
ENERGY STAR Dishwashers	33,245	0	0	0	0	0
ENERGY STAR Dehumidifiers	115,083	115,083	115,083	54,581	54,581	25,409
Heat Pump Dryer	64,594	0	0	0	0	0
2nd Refrigerator Turn-In	1,340,234	1,340,234	1,340,234	846,202	846,202	389,053
2nd Freezer Turn-In	94,465	94,465	94,465	59,638	59,638	27,420
2nd Dehumidifier Turn-In	2,654	2,654	2,654	1,673	1,673	769
Electronics						
Controlled Power Strips	99,152	0	0	0	0	0
Efficient Set Top Box	184,053	184,053	184,053	114,535	114,535	52,729
Efficient Desktop PCs	325,626	325,626	325,626	178,022	178,022	82,184
Efficient Laptop PCs	49,906	81,304	81,304	35,185	35,185	16,243
Efficient Televisions	840,847	840,847	840,847	612,254	612,254	281,336
Efficient Computer Monitors	116,891	116,891	116,891	79,380	79,380	36,545
Lighting						
Specialty CFL Bulbs	1,239,341	1,239,341	1,239,341	442,841	442,841	204,616
Standard Screw-In CFL Bulbs	889,373	889,373	889,373	386,256	386,256	178,258
LED Screw-In	940,395	940,395	940,395	190,337	190,337	88,373

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE –UCT- (MWH)
Bulbs						
Specialty LED Bulbs	1,430,251	1,430,251	1,430,251	300,369	300,369	139,386
Exterior Lighting - CFL Bulbs	147,645	147,645	147,645	27,170	27,170	12,667
Exterior Lighting - LED Bulbs	987,398	987,398	987,398	539,087	539,087	250,344
Efficient Torchiere Floor Lamps	421,159	421,159	421,159	114,586	114,586	53,305
Efficient Fluorescent Tube Lighting	181,345	0	0	0	0	0
LED Night Lights	27,001	27,001	27,001	14,542	14,542	6,747
Occupancy Sensors	186,762	0	0	0	0	0
Holiday Lights	97,240	0	0	0	0	0
Multifamily Common Areas	251,000	217,343	217,343	118,280	118,280	54,641
Water Heating						
Heat Pump Water Heater	575,030	1,150,060	1,150,060	389,759	389,759	181,202
Solar Water Heating	450,528	0	0	0	0	0
Gravity Film Heat Exchanger	127,171	0	0	0	0	0
Pipe Wrap	11,635	11,635	11,635	8,418	8,418	3,868
Low Flow Showerheads	75,232	75,232	75,232	57,109	57,109	26,622
Shower Starters (with LF Showerheads)	25,983	25,983	25,983	17,630	17,630	8,218
Low Flow Faucet Aerators	105,649	105,649	105,649	78,486	78,486	36,591
Other						
Efficient Pool Pump Motors	182,695	182,695	182,695	93,233	93,233	43,384
HVAC (Envelope)						
Ceiling/Attic Insulation	74,820	62,601	58,099	48,958	45,459	22,876
Wall Insulation	42,980	14,364	8,247	8,498	6,021	3,963
Floor Insulation	(33,945)	437	25	100	6	47
Basement Wall Insulation	(7,186)	7,194	1,855	5,017	1,225	2,344
Crawlspace Wall Insulation	(1,220)	4,146	418	1,219	101	570

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE –UCT- (MWH)
Air Sealing	38,097	24,050	24,935	17,637	18,367	8,222
Duct Sealing	11,294	11,743	10,344	8,165	6,909	3,808
Duct Insulation	5,542	5,994	6,333	4,004	4,272	1,863
Duct Location (move into conditioned space)	30,100	40,936	17,730	16,743	5,665	7,815
ENERGY STAR Windows	160,090	161,380	184,539	105,692	120,651	49,387
Window Film	79,231	72,794	30,153	47,891	19,838	22,378
ENERGY STAR Doors	65,802	0	0	0	0	0
Cool Roof	95,434	461	461	65	65	30
Low Income Weatherization Package	155,032	11,385	7,876	8,998	6,230	4,205
Steam Pipe Insulation	(1,417)	(1,417)	(1,417)	(571)	(571)	(265)
HVAC (Equipment)						
ENERGY STAR Air Source Heat Pumps	20,767	24,272	25,483	5,681	5,983	2,647
ENERGY STAR Dual Fuel Heat Pumps	116,396	116,396	63,436	23,315	13,040	10,890
Geothermal Heat Pumps	20,568	0	0	0	0	0
ENERGY STAR Central Air Conditioners	1,098,292	1,098,292	1,081,186	217,727	214,015	101,607
ENERGY STAR Room Air Conditioners	84,075	84,075	84,075	16,147	16,147	7,527
Room Air Conditioner Recycling	163,336	163,336	163,336	54,606	54,606	25,102
Central AC Tune-Up	104,736	104,736	97,106	31,629	33,162	14,561
Ductless Mini-Split Systems	162,204	4,537	4,537	1,138	1,138	530
Thermostat setback strategies	143,606	159,943	64,157	83,164	32,397	38,402
Whole House Fans	247,667	0	0	0	0	0
Efficient Chillers	46,491	46,491	46,491	13,701	13,701	6,301
Chiller Controls	26,584	26,584	30,369	6,817	7,779	3,176
Efficient Furnaces	789,138	789,716	0	255,220	0	119,181

END USE	TECHNICAL POTENTIAL (MWH)	ECONOMIC POTENTIAL -UCT- (MWH)	ECONOMIC POTENTIAL -TRC- (MWH)	ACHIEVABLE POTENTIAL -UCT- (MWH)	ACHIEVABLE POTENTIAL -TRC- (MWH)	CONSTRAINED ACHIEVABLE –UCT- (MWH)
Efficient Boilers	(29,431)	(33,455)	(10,519)	(10,283)	(3,473)	(4,801)
Boiler Controls	(1,156)	(1,143)	(2,616)	(600)	(1,370)	(280)
Boiler Tune-Up	(83)	(116)	(583)	(47)	(238)	(22)
Behavioral Programs						
Direct Feedback (In-Home Energy Display)	260,333	260,333	260,333	199,864	199,864	92,577
Indirect Feedback (Monthly Energy Use Reports)	233,909	233,909	233,909	176,795	176,795	82,091
Total	**16,104,075**	**14,691,791**	**13,688,112**	**6,160,705**	**5,811,199**	**2,851,602**
% of Annual 2022 Sales Forecast	*46.7%*	*42.6%*	*39.7%*	*17.9%*	*16.8%*	*8.3%*
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the Economic screening						

6.2 RESIDENTIAL NATURAL GAS POTENTIAL

Natural gas consumption forecasts for the residential, commercial and institutional segments of the Michigan economy indicate that natural gas demand will decrease from nearly 653 million MMBTu in 2014 to 603 million MMBTu in 2023 (representing a compound average annual rate of growth of -0.9%)[29]. The residential sector is expected to decline more rapidly compared to the state as a whole, with a forecasted average annual growth rate for 2014 to 2023 of -1.2%. The residential gas potential calculations are based upon these approximate consumption values and sales forecast figures over the time horizon covered by the study. The potential is calculated for the entire residential sector and includes breakdowns of the potential associated with each end use.

6.2.1 Energy Efficiency Measures Examined

For the residential sector, there were 673 natural gas savings measures included in the potential gas savings analysis[30]. Table 6-18 provides a brief description of the types of measures included for each end use in the residential model. The list of measures was developed based on a review of the MEMD and measures found in other residential potential studies and TRMs in the Midwest. Measure data includes incremental costs, electricity energy and demand savings, gas and water savings, and measure life.

Table 6-18: Measures and Programs Included in the Gas Residential Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
HVAC Envelope	Building Envelope Upgrades	• Air/duct Sealing • Duct Insulation • Improved Insulation (Wall, Ceiling, and Floor)

[29] Estimated for statewide sales based on Michigan utility load forecast data and historical sales.
[30] This total represents the number of unique energy efficiency measures and all permutations of these unique measures. For example, there are 15 permutations of the "Setback Thermostat" measure to account for the various housing types, heating/cooling combinations, and construction types.

		• Efficient Windows • Window film • ENERGY STAR doors • Cool Roofs • Low Income Weatherization Package
HVAC Equipment	Heating/Cooling/Ventilation Equipment	• Existing Gas Furnace/Boiler Tune-up • Efficient Gas Furnaces • Efficient Gas Boilers • Boiler Controls • Set Back Thermostats
Water Heating	Domestic Hot Water	• Efficient Gas Storage Tank WH • Tankless Gas WH • Low Flow Showerhead/Faucet Aerator • Pipe Wrap • Gravity Film Heat Exchangers
Appliances	High-Efficiency Appliances / Retirement of Inefficient Appliances	• ENERGY STAR Clothes Washers • ENERGY STAR Dishwashers
Behavioral	Consumer Response to Feedback from Utility	• Direct (Real-Time) Feedback • Indirect Feedback

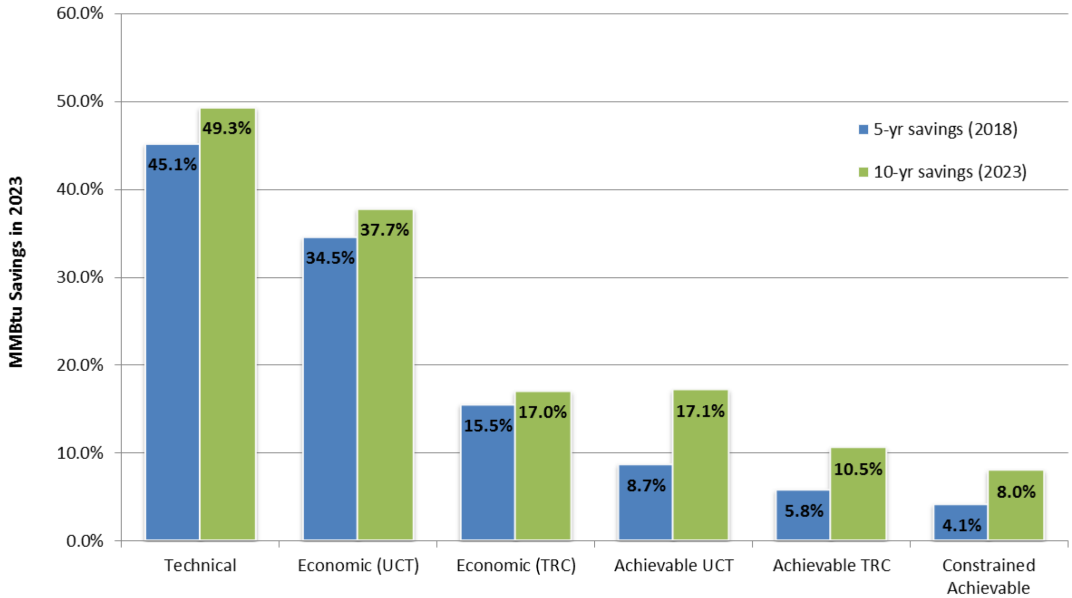
6.2.2 Overview of Residential Natural Gas Energy Efficiency Potential

This section presents estimates for gas technical, economic, and achievable potential for the residential sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative energy savings (MMBtu) percentage of savings by end use, and savings as a percentage of forecast sales. Data is provided on a 5-year and 10-year time horizon for Michigan.

SUMMARY OF FINDINGS

Figure 6-4 illustrates the estimated savings potential for each of the scenarios included in this study.

Figure 6-4: Summary of Residential Energy Efficiency Potential as a % of 2018 and 2023 Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 sector sales. The technical potential is 45.1% in 2018 and 49.3% in 2023. The 5-year and 10-year economic potential is 34.5% and 37.7% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 15.5% in 2018 and 17.0% in 2023. The significant drop from technical between the two economic potential scenarios indicates that most measures are cost-effective when screening based on the UCT, but fall below the threshold of cost-effectiveness when screening based on the TRC Test.

The 5-year and 10-year achievable potential savings are: 8.7% and 17.1% for the Achievable UCT scenario; 5.8% and 10.5% for the Achievable TRC scenario; and 4.1% and 8.0% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on DSM approximately equal to 2% of future annual residential revenue.

TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if all technologically available energy-efficiency measures are immediately adopted in all feasible instances, regardless of cost. Table 6-19 shows that it is technically feasible to save about 134 million MMBtu in the residential sector between 2014 and 2018 and approximately 138 million MMBtu during the 10 year period from 2014 to 2023 across Michigan, representing 46.2% of 5-year residential sales, and more than 50.4% of 10-year residential sales. The HVAC Equipment end use represents the greatest contributor to the potential at 44% of 10-yr savings, while the HVAC Envelope end use contributes 39% of the 10-yr savings, and the Water Heating end use contributes 21% of the 10-yr savings. Conversely, the lighting end use yields a 7% gain in consumption. While there is significant potential for electric savings in the lighting end use, this potential would produce a negative impact on natural gas potential, due to increased heating requirements associated with efficiency lighting.[31]

Table 6-19: Residential Sector Technical Potential MMBtu Savings by End Use

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Appliances	1,338,540	1%	1,370,972	1%
Electronics	0	0%	0	0%
Lighting	-9,640,240	-7%	-9,873,172	-7%
Water Heating	27,881,414	21%	28,797,984	21%
Other	0	0%	0	0%
HVAC (Envelope)	52,674,854	39%	53,999,996	39%
HVAC (Equipment)	58,927,470	44%	60,733,803	44%
Behavioral Programs	3,259,386	2%	3,331,000	2%
Total	**134,441,426**	**100%**	**138,360,584**	**100%**
% of Annual Sales Forecast	*45.1%*		*49.3%*	

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. Because the TRC includes participant costs, it goes beyond utility resource acquisition and looks at the measure/program from a more broad perspective. 77% of all measures that were included in the electric potential analysis passed the UCT and 63% of all measures passed the TRC Test.

Table 6-20 indicates that the economic potential based on the UCT screen is nearly 103 million MMBTu during the 5 year period from 2014 to 2018. The economic potential increases to nearly 106 million MMBTu during the 10 year period from 2014 to 2023. This represents 34.5% and 37.7% of residential sales across the respective 5-year and 10-year timeframes. Similar to the technical potential scenario, the HVAC Equipment end use represents the greatest contributor to the potential at 59% of the 10-yr savings, while the HVAC Envelope and Water Heating end use contributes 27% and 19% of the 10-yr savings.

Table 6-20: Statewide Residential Sector Economic Potential (UCT) MMBtu Savings by End Use

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-8,368,437	-8%	-8,575,962	-8%

[31] High efficiency lighting reduces the amount of waste heat that is released during hours of lighting operation. The reduction in waste heat places a greater burden on heating equipment (electric and gas) to meet the winter heating load requirements.

Water Heating	19,704,616	19%	20,411,257	19%
Other	0	0%	0	0%
HVAC (Envelope)	27,241,470	26%	28,225,814	27%
HVAC (Equipment)	60,968,435	59%	62,601,345	59%
Behavioral Programs	3,259,386	3%	3,331,000	3%
Total	**102,805,470**	**100%**	**105,993,453**	**100%**
% of Annual Sales Forecast	*34.5%*		*37.7%*	

Table 6-21 demonstrates that the economic potential based on the TRC screen is lower than the economic potential based on the UCT screen. In 2023, economic potential based on the TRC cost-effectiveness screening is approximately 58 million MMBtu lower than the economic potential based on the UCT. The biggest decline in economic potential between the two screens occurred in the HVAC (Equipment) end-use where measure costs are high and incentive amounts can significantly impact cost-effectiveness.

Table 6-21: Statewide Residential Sector Economic Potential (TRC) MMBtu Savings by End Use

END USE	2018 SAVINGS (MMBTU)	% OF 2018 SAVINGS	2023 SAVINGS (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-8,368,437	-18%	-8,575,962	-18%
Water Heating	6,609,000	14%	6,934,469	15%
Other	0	0%	0	0%
HVAC (Envelope)	22,425,304	49%	23,076,112	48%
HVAC (Equipment)	22,179,133	48%	22,869,996	48%
Behavioral Programs	3,259,386	7%	3,331,000	7%
Total	**46,104,387**	**100%**	**47,635,614**	**100%**
% of Annual Sales Forecast	*15.5%*		*17.0%*	

6.2.3 Achievable Natural Gas Potential Savings in the Residential Sector

Achievable potential is a refinement of economic potential that takes into account the estimated market adoption of energy efficiency measures based on the incentive level and measure payback, the natural replacement cycle of equipment, and the capabilities of programs and administrators to ramp up program activity over time. Achievable potential also takes into account the non-measure costs of delivering programs (for administration, marketing, monitoring and evaluation, etc.). As noted in Section 6.1.3, administrative costs were assumed to be equivalent to 20% of incremental measures costs.

This study estimated achievable potential for three scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

6.2.3.1 Achievable UCT vs. Achievable TRC

Tables 6-22 and 6-23 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include estimated 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is 18 million MMBTu greater, over the next decade, than the achievable TRC scenario.

Table 6-22: Residential Achievable UCT Natural Gas Potential Savings by End Use

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-1,604,584	-6%	-2,603,302	-5%
Water Heating	4,674,296	18%	8,195,577	17%
Other	0	0%	0	0%
HVAC (Envelope)	8,303,866	32%	17,078,017	35%
HVAC (Equipment)	11,882,237	46%	22,901,439	48%
Behavioral Programs	2,533,522	10%	2,541,015	5%
Total	**25,789,337**	**100%**	**48,112,745**	**100%**
% of Annual Sales Forecast	*8.7%*		*17.1%*	

Table 6-23: Residential Achievable TRC Potential Natural Gas Savings by End Use

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-1,604,584	-9%	-2,603,302	-9%
Water Heating	3,410,886	20%	5,615,133	19%
Other	0	0%	0	0%
HVAC (Envelope)	7,160,065	42%	14,765,283	50%
HVAC (Equipment)	5,629,802	33%	9,258,416	31%
Behavioral Programs	2,533,522	15%	2,541,015	9%
Total	**17,129,691**	**100%**	**29,576,545**	**100%**
% of Annual Sales Forecast	*5.8%*		*10.5%*	

The 5-year and 10-year Achievable UCT potential savings estimates are approximately 26 million MMBTu and 48 million MMBTu. This equates to 8.7% and 17.1% of sector sales in 2018 and 2023. By comparison, the respective 5-year and 10-year Achievable TRC potential savings estimates are approximately 17 million MMBTu and 30 million MMBTu. This equates to 5.8% and 10.8% of sector sales in 2018 and 2023.

6.2.3.2 Achievable UCT vs. Constrained UCT

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of Michigan utility revenue.

Table 6-24 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Achievable UCT potential savings estimates are approximately 12 million MMBTu and 22 million MMBTu. This equates to 4.1% and 8.0% of sector sales in 2018 and 2023.

Table 6-24: Residential Constrained Achievable Potential Natural Gas Savings by End Use

END USE	2018 ENERGY (MMBTU)	% OF 2018 SAVINGS	2023 ENERGY (MMBTU)	% OF 2023 SAVINGS
Appliances	0	0%	0	0%
Electronics	0	0%	0	0%
Lighting	-755,897	-6%	-1,204,841	-5%
Water Heating	2,206,297	18%	3,807,034	17%
Other	0	0%	0	0%
HVAC (Envelope)	3,931,722	32%	7,971,205	36%
HVAC (Equipment)	5,620,094	46%	10,655,713	48%
Behavioral Programs	1,158,492	10%	1,178,163	5%
Total	**12,160,708**	**100%**	**22,407,275**	**100%**
% of Annual Sales Forecast	*4.1%*		*8.0%*	

Figure 6-5 shows the estimated 10-year cumulative efficiency savings for the Constrained UCT Achievable potential scenario, broken out by end use across the entire residential sector. The HVAC Equipment end use shows the largest potential for savings at nearly 11 million MMBtu, or 47% of total savings. This figure also illustrates the negative impact on natural gas potential, due to increased heating requirements associated with efficiency lighting.

Figure 6-5: Residential Sector 2023 Achievable Potential Savings for the Constrained UCT Scenario, by End Use

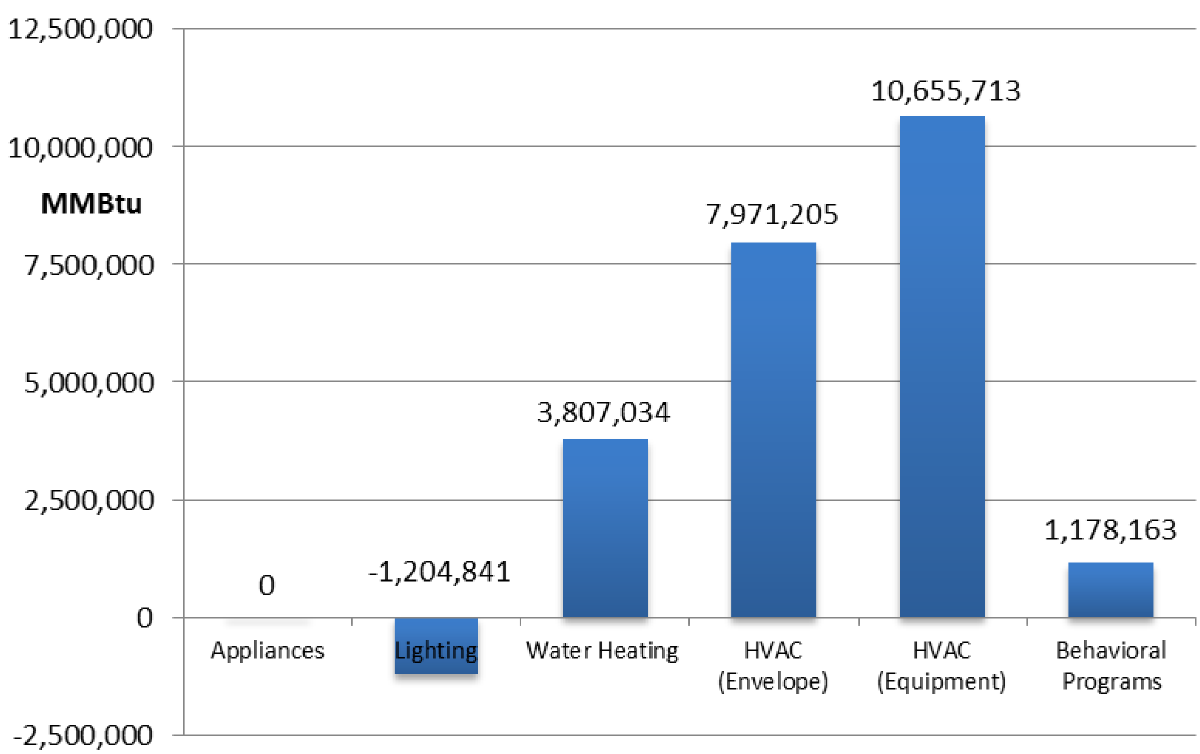
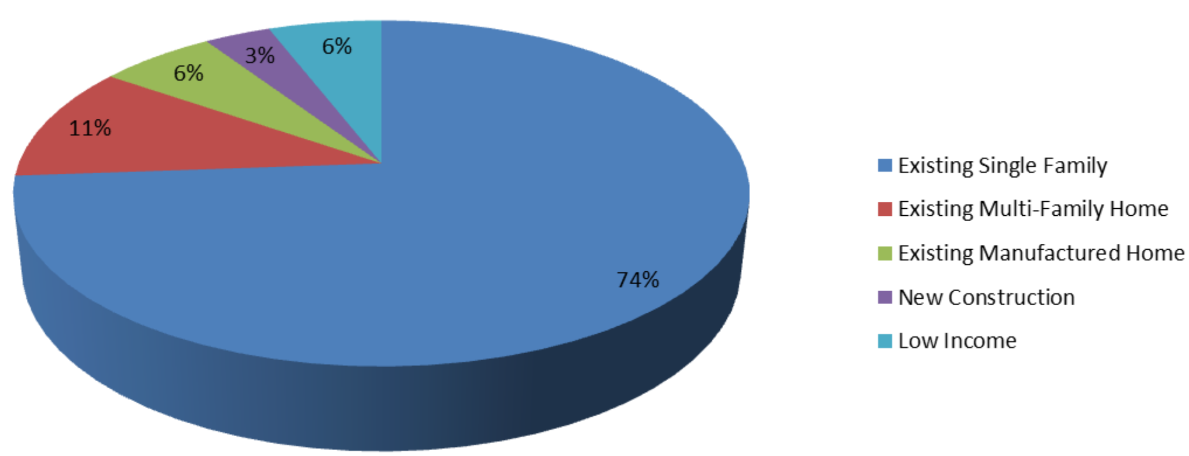


Figure 6-6 shows the breakdown of estimated savings in 2023 by housing type, low-income designation and new construction measures, for the Base Achievable potential scenario. The savings are largely coming from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed. The existing single-family housing and existing multi-family housing types lead the way with 74% of savings and 11% savings, respectively, followed by and 6% coming from manufactured. New construction measures account for 3% of total savings and low-income measures account for 6% of total savings. As noted in the electric potential portion of this section, the low-income measures represent only those measures typically included in the Michigan Weatherization Assistance Program to low-income households, and do not represent the combined "low-income potential" in Michigan. There is also low-income potential that is subsumed by the other 93% of the savings associated with the "non-low-income" measures. For example, low income households could realize additional behavioral program energy efficiency savings, even though they may not be offered under the traditional umbrella of low-income programs.

Figure 6-6: Residential Constrained UCT Achievable Savings in 2023, by Housing Type, Low-Income Designation and New Construction Measures



6.2.4 Annual Achievable Natural Gas Savings Potential

Table 6-25, Table 6-26 and Table 6-27 shows cumulative annual energy savings for all three achievable potential scenarios for each year across the 10-year time horizon for the study, broken out by end use. The year by year associated incentive and administrative costs to achieve these savings are shown later, in Section 1.3.

Table 6-25: Cumulative Annual Residential Energy Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

End-Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	0	0	0	0	0	0	0	0	0	0
Electronics	0	0	0	0	0	0	0	0	0	0
Lighting	-260,607	-579,333	-931,504	-1,271,211	-1,604,584	-1,926,480	-2,233,932	-2,422,620	-2,597,117	-2,603,302
Water Heating	760,541	1,682,745	2,675,295	3,670,329	4,674,296	5,677,134	6,439,350	7,058,554	7,626,279	8,195,577
Other	0	0	0	0	0	0	0	0	0	0
HVAC (Envelope)	1,578,090	3,195,949	4,859,590	6,559,806	8,303,866	10,052,795	11,804,548	13,558,645	15,316,630	17,078,017
HVAC (Equipment)	2,342,486	4,753,394	7,226,178	9,545,160	11,882,237	14,201,918	16,531,522	18,871,274	21,224,746	22,901,439
Behavioral Programs	586,587	1,249,222	2,066,926	2,376,431	2,533,522	2,535,927	2,537,906	2,538,915	2,539,946	2,541,015
Total	**5,007,098**	**10,301,977**	**15,896,486**	**20,880,516**	**25,789,337**	**30,541,295**	**35,079,396**	**39,604,769**	**44,110,483**	**48,112,745**
% of Annual Forecast Sales	*1.6%*	*3.3%*	*5.2%*	*6.9%*	*8.7%*	*10.4%*	*12.1%*	*13.8%*	*15.5%*	*17.1%*

Table 6-26: Cumulative Annual Residential Energy Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

End-Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	0	0	0	0	0	0	0	0	0	0
Electronics	0	0	0	0	0	0	0	0	0	0
Lighting	-260,607	-579,333	-931,504	-1,271,211	-1,604,584	-1,926,480	-2,233,932	-2,422,620	-2,597,117	-2,603,302
Water Heating	513,849	1,187,298	1,927,956	2,667,751	3,410,886	4,151,722	4,651,273	5,007,271	5,310,834	5,615,133
Other	0	0	0	0	0	0	0	0	0	0
HVAC (Envelope)	1,352,192	2,743,129	4,178,300	5,648,531	7,160,065	8,675,868	10,194,179	11,714,622	13,238,448	14,765,283
HVAC (Equipment)	1,291,628	2,661,128	4,089,725	4,859,808	5,629,802	6,376,956	7,124,787	7,873,459	8,626,178	9,258,416
Behavioral Programs	586,587	1,249,222	2,066,926	2,376,431	2,533,522	2,535,927	2,537,906	2,538,915	2,539,946	2,541,015
Total	**3,483,650**	**7,261,444**	**11,331,403**	**14,281,310**	**17,129,691**	**19,813,993**	**22,274,214**	**24,711,647**	**27,118,290**	**29,576,545**
% of Annual Forecast Sales	*1.1%*	*2.3%*	*3.7%*	*4.7%*	*5.8%*	*6.7%*	*7.7%*	*8.6%*	*9.5%*	*10.5%*

Table 6-27: Cumulative Annual Residential Energy Savings in the Constrained UCT Potential Scenario, by End Use for Michigan

End-Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Appliances	0	0	0	0	0	0	0	0	0	0
Electronics	0	0	0	0	0	0	0	0	0	0
Lighting	-134,282	-287,076	-448,296	-604,311	-755,897	-902,321	-1,042,874	-1,130,193	-1,210,565	-1,204,841
Water Heating	391,881	833,976	1,291,178	1,749,368	2,206,297	2,662,878	2,997,366	3,276,761	3,541,025	3,807,034
Other	0	0	0	0	0	0	0	0	0	0
HVAC (Envelope)	813,137	1,588,721	2,355,051	3,137,961	3,931,722	4,727,986	5,528,529	6,338,712	7,153,339	7,971,205
HVAC (Equipment)	1,207,004	2,362,769	3,501,817	4,560,549	5,620,094	6,673,549	7,736,917	8,818,791	9,910,824	10,655,713
Behavioral Programs	302,249	605,711	968,990	1,100,891	1,158,492	1,157,090	1,158,022	1,166,919	1,173,014	1,178,163
Total	**2,579,989**	**5,104,101**	**7,668,740**	**9,944,458**	**12,160,708**	**14,319,181**	**16,377,959**	**18,470,990**	**20,567,637**	**22,407,275**
% of Annual Forecast Sales	*0.8%*	*1.6%*	*2.5%*	*3.3%*	*4.1%*	*4.9%*	*5.6%*	*6.4%*	*7.2%*	*8.0%*

6.2.5 Residential Gas Savings Summary by Measure Group

Table 6-28 provides an end-use breakdown of the residential natural gas savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained Achievable potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 6-28: Breakdown of Residential Cumulative Annual Gas Savings Potential for Technical, Economic and Achievable Potential, by End Use for Michigan

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBTu)	Achievable Potential -TRC- (MMBTu)	Constrained Achievable –UCT- (MMBTu)
Appliances						
ENERGY STAR Clothes Washers	1,234,592	0	0	0	0	0
ENERGY STAR Dishwashers	136,380	0	0	0	0	0
Lighting						
Specialty CFL Bulbs	(2,058,084)	(2,058,084)	(2,058,084)	(735,395)	(735,395)	(339,790)
Standard Screw-In CFL Bulbs	(1,476,918)	(1,476,918)	(1,476,918)	(641,428)	(641,428)	(296,021)
LED Screw-In Bulbs	(1,561,646)	(1,561,646)	(1,561,646)	(316,079)	(316,079)	(146,755)
Specialty LED Bulbs	(2,375,116)	(2,375,116)	(2,375,116)	(498,801)	(498,801)	(231,468)
Efficient Torchiere Floor Lamps	(699,389)	(699,389)	(699,389)	(190,286)	(190,286)	(88,519)
LED Night Lights	(44,839)	(44,839)	(44,839)	(24,148)	(24,148)	(11,205)
Occupancy Sensors	(1,240,572)	0	0	0	0	0
Water Heating						
Heat Pump Water Heater	(937,885)	(1,875,770)	(1,875,770)	(635,704)	(635,704)	(295,543)
Solar Water Heating	8,286,727	0	0	0	0	0
Efficient Gas Tank Water Heater	3,140,233	4,710,334	0	901,638	0	421,037
Instant Gas Water Heater	5,844,323	8,766,454	0	1,678,806	0	783,946
Gravity Film Heat Exchanger	3,654,347	0	0	0	0	0
Pipe Wrap	3,477,824	3,477,824	3,477,824	2,627,519	2,627,519	1,207,373
Low Flow Showerheads	1,941,229	1,941,229	1,941,229	1,390,732	1,390,732	648,559

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBTu)	Achievable Potential -TRC- (MMBTu)	Constrained Achievable –UCT- (MMBTu)
Shower Starters (with LF Showerheads)	670,558	670,558	670,558	381,018	381,018	177,908
Low Flow Faucet Aerators	2,720,628	2,720,628	2,720,628	1,851,568	1,851,568	863,753
HVAC (Envelope)						
Ceiling/Attic Insulation	7,791,198	6,390,932	6,233,309	5,004,468	4,891,759	2,338,407
Wall Insulation	4,493,323	1,421,081	968,462	857,292	741,256	400,097
Floor Insulation	4,180,783	58,371	3,271	13,394	733	6,253
Basement Wall Insulation	4,848,806	521,736	0	370,421	0	173,089
Crawlspace Wall Insulation	732,648	234,224	131,659	69,777	39,003	32,603
Air Sealing	3,765,523	2,575,640	2,719,675	1,891,550	2,009,313	882,237
Duct Sealing	629,201	623,609	555,991	444,698	386,216	207,298
Duct Insulation	879,115	593,740	398,685	335,998	182,023	156,653
Duct Location (move into conditioned space)	2,731,764	5,070,233	494,952	2,205,648	109,915	1,030,621
ENERGY STAR Windows	7,054,965	6,960,863	7,131,534	4,558,800	4,670,308	2,130,208
Window Film	(1,825,011)	(1,526,687)	(653,436)	(1,004,419)	(429,908)	(469,342)
ENERGY STAR Doors	4,684,290	0	0	0	0	0
Cool Roof	(1,606,568)	(3,106)	(3,106)	(436)	(436)	(201)
Low Income Weatherization Package	10,745,099	410,317	200,255	324,057	158,332	151,425
Steam Pipe Insulation	4,894,860	4,894,860	4,894,860	2,006,769	2,006,769	931,858
HVAC (Equipment)						
ENERGY STAR Dual Fuel Heat Pumps	(37,063)	(37,063)	(10,189)	(5,564)	(1,308)	(2,600)
Geothermal Heat Pumps	7	0	0	0	0	0
ENERGY STAR Central Air Conditioners	7,234,324	7,234,324	6,975,083	1,410,030	1,347,399	658,139
Thermostat	11,794,373	13,908,847	4,294,230	7,283,592	2,187,854	3,363,501

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBTu)	Achievable Potential -TRC- (MMBTu)	Constrained Achievable –UCT- (MMBTu)
setback strategies						
Whole House Fans	(65,245)	0	0	0	0	0
Efficient Furnaces	35,406,644	34,818,724	0	11,377,112	0	5,314,675
Furnace Tune-Up	999,315	987,358	3,958,744	511,649	2,062,686	236,995
Efficient Boilers	2,498,142	2,835,625	1,314,253	869,116	433,848	405,691
Boiler Tune-up	1,338,454	1,354,834	2,986,018	672,878	1,476,311	313,825
Boiler Controls	1,564,567	1,498,410	3,351,571	782,527	1,751,527	365,442
Behavioral Programs						
Direct Feedback (In-Home Energy Display)	1,962,884	1,962,884	1,962,884	1,506,955	1,506,955	698,019
Indirect Feedback (Monthly Energy Use Reports)	1,368,116	1,368,116	1,368,116	1,034,060	1,034,060	480,143
Total	**138,360,584**	**105,993,453**	**47,635,614**	**48,112,745**	**29,576,545**	**22,407,275**
% of Annual 2022 Sales Forecast	*49.3%*	*37.7%*	*17.0%*	*17.1%*	*10.5%*	*8.0%*
Note: Measures in the above table with "0" potential are ones that did not pass the economic screen.						

6.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

The tables below provide the net present value (NPV) benefits and costs associated with the three achievable potential scenarios for the residential sector at the 5-year and 10-year periods. Table 6-29 and Table 6-30 compares the NPV benefits and costs associated with the Achievable UCT and Achievable TRC Scenarios. Both the UCT and TRC scenario benefits include avoided energy supply and demand costs, while the Achievable TRC scenario benefits also include O&M benefits, tax credits, and water benefits. The NPV costs in the Achievable UCT scenario includes only program administrator costs (incentives paid, staff labor, marketing, etc.) whereas the Achievable TRC scenario costs include both participant and program administrator costs.

Table 6-29: 5-Year Benefit-Cost Ratios for Achievable UCT vs. Achievable TRC Scenarios – Residential Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$3,351,551,279	$1,273,399,237	2.63
Achievable TRC	$3,451,174,354	$1,438,462,742	2.40

Table 6-30: 10-Year Benefit-Cost Ratios for Achievable UCT vs. Achievable TRC Scenarios– Residential Sector Only

10-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$6,211,177,018	$2,252,191,417	2.76
Achievable TRC	$6,232,698,433	$2,529,103,408	2.46

Table 6-31 and Table 6-32 compares the NPV benefits and costs associated with the Achievable UCT and Constrained UCT Scenarios. Both scenarios compared the benefits and costs based on the UCT. However the constrained scenario's 2% of revenue spending cap on DSM results in reduced program participation and overall NPV benefits.

Table 6-31: 5-Year Benefit-Cost Ratios for Achievable UCT vs. Constrained UCT Scenarios – Residential Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
ACHIEVABLE UCT	$3,351,551,279	$1,273,399,237	2.63
CONSTRAINED UCT	$1,585,089,814	$622,859,096	2.54

Table 6-32: 10-Year Benefit-Cost Ratios for Achievable UCT vs. Constrained UCT Scenarios– Residential Sector Only

10-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$6,211,177,018	$2,252,191,417	2.76
Constrained UCT	$2,898,576,912	$1,084,251,736	2.67

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Tables 6-33 through 6-35.

Table 6-33: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

ACHIEVABLE UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$190.5	$203.8	$212.7	$214.0	$216.6	$217.2	$217.4	$216.2	$216.5	$216.7
Admin.	$74.1	$78.5	$82.0	$82.5	$83.6	$83.8	$83.9	$83.4	$83.5	$83.6
Total Costs	**$264.6**	**$282.2**	**$294.7**	**$296.5**	**$300.2**	**$301.0**	**$301.4**	**$299.6**	**$300.0**	**$300.3**

Table 6-34: Annual Program Budgets Associated with the Achievable TRC Scenario (in millions)

ACHIEVABLE TRC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$125.8	$139.1	$147.6	$148.6	$150.6	$150.7	$150.6	$149.0	$148.8	$148.5
Admin.	$47.7	$52.0	$55.4	$55.8	$56.6	$56.7	$56.6	$56.0	$55.9	$55.8
Total Costs	**$173.5**	**$191.1**	**$203.1**	**$204.4**	**$207.2**	**$207.4**	**$207.2**	**$204.9**	**$204.6**	**$204.3**

Table 6-35: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

CONSTRAINED UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$98.2	$97.7	$98.0	$98.5	$98.6	$98.9	$99.4	$99.9	$100.3	$100.6
Admin.	$38.2	$37.6	$37.8	$38.0	$38.0	$38.2	$38.3	$38.5	$38.7	$38.8
Total Costs	**$136.4**	**$135.3**	**$135.7**	**$136.5**	**$136.6**	**$137.0**	**$137.7**	**$138.4**	**$139.0**	**$139.5**

7 COMMERCIAL ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides electric and natural gas energy efficiency potential estimates for the commercial sector in Michigan. Estimates of technical, economic and achievable potential are provided in separate sections for electric and natural gas.

7.1 COMMERCIAL ELECTRIC ENERGY EFFICIENCY POTENTIAL

According to 2012 historical sales data[32], the commercial sector accounts for approximately 37% of retail electric sales in Michigan, but only 11% of the total retail customers. The average commercial customer consumes roughly 74,000 kWh annually. Comparatively, the average residential consumer in Michigan uses approximately 8,200 kWh per year. Commercial kWh sales over the period 2002 to 2012 have increased by a total of 6.9%, peaking at 40, 047 million kWh in 2007 and then declining to a 2012 level of 38,367 million kWh. For this study, commercial electric sales are estimated to remain relatively stable at their 2012 level over the 10 year study period of 2014 – 2023.[33]

7.1.1 Electric Energy Efficiency Measures Examined

For the commercial sector, there were 180 unique energy efficiency measures included in the energy savings potential analysis. Table 7-1 provides a brief description of the types of measures included for each end use in the commercial sector. The list of measures was developed based on a review of the Michigan Energy Measures Database (MEMD), measures found in other Technical Reference Manuals (TRMs) and measures included in other commercial energy efficiency potential studies. For each measure, the analysis considered incremental costs, energy and demand savings, and measure useful lives.

Table 7-1: Types of Electric Measures Included in the Commercial Sector Analysis

End Use Type	End Use Description	Measures Included
Compressed Air	Compressor Equipment	• Efficient Air Compressors • Automatic Drains • Cycling and High Efficiency Dryers • Low Pressure Drop-Filters • Air-Entraining Air Nozzles • Receiver Capacity Addition • Compressed Air Audits, Leak Repair, and Flow Control
Computers & Office Equipment	Equipment Improvements	• High Efficiency Office Equipment • Smart Power Strips • Computer Energy Management Controls
Cooking	Cooking Equipment Improvements	• Efficient Cooking Equipment
Lighting	Lighting Improvements	• Efficient Lighting Equipment • Fixture Retrofits • Ballast Replacement • Premium Efficiency T8 and T5 • High Bay Lighting Equipment • LED Bulbs and Fixtures • Light Tube • CFL Retrofits

32 U.S. Energy Information Administration

33 GDS forecast based on kWh sales forecasts provided by DTE Energy and Consumers Energy (CE) and historical commercial kWh sales trends for the state as a whole.

End Use Type	End Use Description	Measures Included
		• Lighting Controls • Efficient Design for New Construction
Building Envelope	Space Heating and Space Cooling	• Building Envelope Improvements • Cool Roofing • Integrated Building Design
Pools	Pool Equipment	• Efficient Equipment and Controls • Heat Pump Pool Heaters • Solar Water Heating
Refrigeration	Refrigeration Improvements	• Vending Misers • Refrigerated Case Covers • Economizers • Efficient Refrigeration • Upgrades Motors and Controls • Door Heater Controls • Efficient Compressors and Controls • Door Gaskets and Door Retrofits • Refrigerant Charging Correction
Space Cooling	Cooling System Upgrades	• Efficient Chillers • Efficient Cooling Equipment • Chiller Tune-up/Diagnostics • High Efficiency Pumps
Space Heating	Heating System Improvements	• Efficient Heating Equipment • Efficient Heating Pumps and Controls
Other	Transformer Equipment Other	• Efficient Transformers • Vending Miser for Non-Refrig Equip • Optimized Snow and Ice Melt Controls • EC Plug Fans in Data Centers
Ventilation	Ventilation Equipment	• Enthalpy Economizer • Demand-Controlled Ventilation • Variable Speed Drive Controls • Improved Duct Sealing • Electronically-Commutated Permanent Magnet Motors • Destratification Fans • Controlled Ventilation Optimization • High Performance Air Filters
Water Heating	Water Heating Improvements	• Efficient Equipment • High Efficiency HW Appliances • Ozone Laundry System • Low Flow Equipment • Pipe and Tank Insulation • Heat Recovery Systems • Efficient HW Pump and Controls • Solar Water Heating System
HVAC Controls	Space Cooling and Space Heating	• Programmable Thermostats • EMS Installation/Optimization • Hotel Guest Room Occupancy Control System • Zoning

7.1.2 Technical and Economic Potential Electric Savings

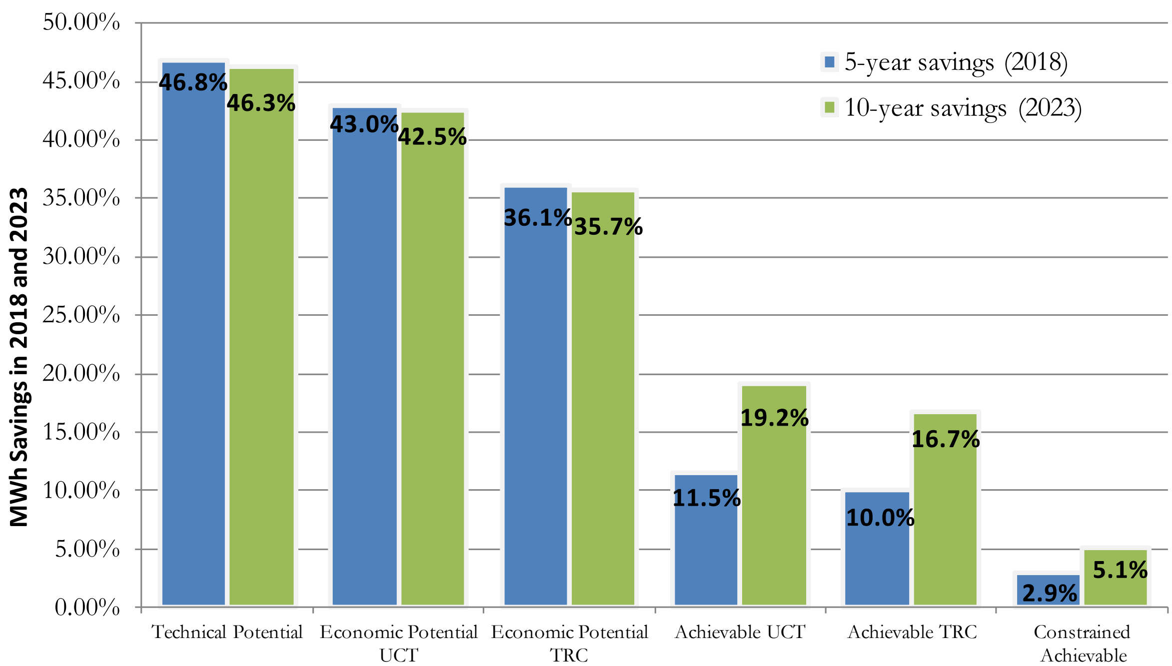
This section presents estimates for electric technical, economic, and achievable savings potential for the commercial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative savings (MWh) and percentage of annual MWH sales. Data is provided for a 5 and 10-year horizon for Michigan

This energy efficiency potential study considers the impacts of the December 2007 Energy and Independence and Security Act (EISA) as an improving code standard for the commercial sector. EISA improves the baseline efficiency of compact fluorescent lamps (CFL), general service fluorescent lamps (GSFL), high intensity discharge (HID) lamps and ballasts and motors, all applicable in the commercial sector.

SUMMARY OF FINDINGS

Figure 7-1 illustrates the estimated energy efficiency savings potential in Michigan for each of the scenarios included in this study.

Figure 7-1: Summary of Commercial Electric Energy Efficiency Potential as a % of Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 commercial sector sales forecasts. The technical potential is 27.7% in 2018 and 46.3% in 2023. The 5-year and 10-year economic potential is 25.5% and 42.5% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 21.4% in 2018 and 35.7% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 11.5% and 19.2% for the Achievable UCT scenario; 10.0% and 16.7% for the Achievable TRC scenario; and 2.9% and 5.1% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained

Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual commercial and industrial revenue. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found.

TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 7-2 shows that it is technically feasible to save approximately 10.6 million MWh annually in the commercial sector by 2018, and approximately 18.0 million MWh annually by 2023 across Michigan, representing 27.5% of the commercial sales forecast in 2018, and 46.3% of the commercial sales forecast in 2023. Lighting represents the majority of the energy efficiency savings potential at 40% of 10-yr savings, while space heating, cooking and pools represent the smallest shares, each with 1 percent or less of 10-yr savings. Table 7-3 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 3,630 MW and 6,153 MW, respectively, which is 34.2% and 57.0% of the peak forecasts for 2018 and 2023 respectively.

Table 7-2: Commercial Sector Technical Potential Savings by End Use

Commercial Technical Potential Savings by End Use				
End Use	**2018 Energy Savings (MWh)**	**% of 2018 Total**	**2023 Energy Savings (MWh)**	**% of 2023 Total**
Lighting	7,176,334	40%	7,205,943	40%
Ventilation	2,746,930	15%	2,759,454	15%
Refrigeration	3,462,824	19%	3,478,837	19%
Other	694,282	4%	697,479	4%
Compressed Air	621,671	3%	621,671	3%
Space Cooling	425,756	2%	427,578	2%
Office Equipment	909,504	5%	913,710	5%
Space Heating	208,447	1%	209,411	1%
HVAC Controls	333,058	2%	334,531	2%
Water Heating	353,080	2%	354,708	2%
Building Envelope	790,019	4%	795,331	4%
Cooking	128,779	1%	129,374	1%
Pools	25,827	0%	25,946	0%
Total	**17,876,511**	**100%**	**17,953,973**	**100%**
% of Annual Sales Forecast	*46.6%*		*46.3%*	

Table 7-3: Commercial Sector Technical Potential Demand Savings

Commercial Technical Potential Savings Demand Savings		
	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	**6,127**	**6,153**
% of Peak	*57.6%*	*57.0%*

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential and only includes measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. The TRC Test was also included because it also considers the cost assumed by the participant as well as all utility costs. 87% of all measures that were included in the electric potential analysis passed the UCT and 75% of all measures passed the TRC Test.

Table 7-4 indicates that the economic potential based on the UCT screen is nearly 10 million MWh annually by 2018, and the economic potential increases to approximately 16.5 million MWh annually by 2023. This represents 25.2% and 42.5% of commercial sales across the respective 5-year and 10-year timeframes. Lighting, ventilation, and refrigeration make up a majority of the savings. Table 7-5 shows the peak demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 3,208 MW and 5,438 MW, respectively, which is 30.2% and 50.4% of the peak forecasts in 2018 and 2013 respectively.

Table 7-4: Commercial Sector Economic Potential (UCT) Savings by End Use

Commercial Economic Potential (UCT) Savings by End Use				
End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Lighting	6,914,755	42%	6,944,274	42%
Ventilation	2,447,532	15%	2,458,805	15%
Refrigeration	3,408,903	21%	3,424,667	21%
Other	694,282	4%	697,479	4%
Compressed Air	620,398	4%	620,398	4%
Space Cooling	277,633	2%	278,770	2%
Office Equipment	693,089	4%	696,295	4%
Space Heating	128,352	1%	128,945	1%
HVAC Controls	333,058	2%	334,531	2%
Water Heating	342,925	2%	344,505	2%
Building Envelope	418,284	3%	423,595	3%
Cooking	122,452	1%	123,019	1%
Pools	25,827	0%	25,946	0%
Total	**16,427,488**	**100%**	**16,501,229**	**100%**
% of Annual Sales Forecast	*42.8%*		*42.5%*	

Table 7-5: Commercial Sector Economic Potential (UCT) Demand Savings

Commercial Economic Potential Savings Demand Savings		
	Summer Peak Demand	
	2018	2023
Summary	MW	MW
Total	**5,414**	**5,438**
% of Peak	*50.9%*	*50.4%*

Table 7-6 shows that the economic potential based on the TRC screen is slightly over 8 million MWh annually by 2018, and the economic potential increases to approximately 13.6 million MWh annually by 2023. This represents 21% and 35% of commercial MWH sales forecast for 2018 and 2023 respectively. As with UCT economic potential, lighting, ventilation, and refrigeration again make up a majority of the economic TRC savings potential. Table 7-7 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 2,755 MW and 4,669 MW, respectively, which is 25.9% and 43.2% of the peak forecasts for those years.

7-6: Commercial Sector Economic Potential (TRC) Savings by End Use

Commercial Economic Potential (TRC) Savings by End Use				
End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Lighting	4,851,533	35%	4,880,285	35%
Ventilation	2,462,257	18%	2,473,645	18%
Refrigeration	3,366,870	24%	3,382,440	24%
Other	650,368	5%	653,362	5%
Compressed Air	617,266	4%	617,266	4%
Space Cooling	277,206	2%	278,341	2%
Office Equipment	693,089	5%	696,295	5%
Space Heating	8,004	0%	8,041	0%
HVAC Controls	333,058	2%	334,531	2%
Water Heating	336,438	2%	337,989	2%
Building Envelope	55,057	0%	60,369	0%
Cooking	108,343	1%	108,844	1%
Pools	25,827	0%	25,946	0%
Total	**13,785,317**	**100%**	**13,857,354**	**100%**
% of Annual Sales Forecast	*35.9%*		*35.7%*	

Table 7-7: Commercial Sector Economic Potential Demand Savings

Commercial Economic Potential Savings Demand Savings		
	Summer Peak Demand	
	2018	2023
Summary	MW	MW
Total	**4,642**	**4,666**
% of Peak	*43.7%*	*43.2%*

7.1.3 Achievable Potential Savings in the Commercial Sector

Achievable potential is an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles. This study estimated achievable potential for three scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. Unlike the economic potential, the commercial achievable potential takes into account the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment. The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of annual utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

7.1.3.1 UCT vs. TRC

Tables 7-8 through 7-11 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is approximately 1 million MWh greater on an annual basis, over the next decade, than the achievable TRC scenario.

Table 7-8: Commercial Achievable UCT Potential Electric Energy Savings by End Use

Commercial Maximum Achievable (UCT) Savings by End Use				
End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Lighting	1,761,040	40%	2,984,813	40%
Ventilation	571,550	13%	968,728	13%
Refrigeration	1,153,176	26%	1,954,536	26%
Other	117,717	3%	199,520	3%
Compressed Air	194,341	4%	329,391	4%
Space Cooling	65,752	1%	111,444	1%
Office Equipment	207,964	5%	352,481	5%
Space Heating	42,806	1%	72,553	1%
HVAC Controls	117,115	3%	198,500	3%
Water Heating	101,916	2%	172,738	2%
Building Envelope	5,947	0%	10,080	0%
Cooking	38,876	1%	65,892	1%
Pools	9,237	0%	15,656	0%
Total	**4,387,436**	**100%**	**7,436,332**	**100%**
% of Annual Sales Forecast	*11.4%*		*19.2%*	

Table 7-9: Commercial Achievable UCT Potential Demand Savings

Commercial Maximum Achievable Potential Savings Demand Savings		
	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,446**	**2,451**
% of Peak	*13.6%*	*22.7%*

Table 7-10: Commercial Achievable TRC Potential Electric Energy Savings by End Use

Commercial Base Achievable (TRC) Savings by End Use				
End Use	**2018 Energy Savings (MWh)**	**% of 2018 Total**	**2023 Energy Savings (MWh)**	**% of 2023 Total**
Lighting	1,272,814	33%	2,157,312	33%
Ventilation	574,563	15%	973,835	15%
Refrigeration	1,139,293	30%	1,931,006	30%
Other	106,626	3%	180,722	3%
Compressed Air	193,733	5%	328,360	5%
Space Cooling	65,661	2%	111,289	2%
Office Equipment	207,964	5%	352,481	5%
Space Heating	1,635	0%	2,771	0%
HVAC Controls	117,115	3%	198,500	3%
Water Heating	99,877	3%	169,284	3%
Building Envelope	1,549	0%	2,625	0%
Cooking	34,566	1%	58,586	1%
Pools	9,237	0%	15,656	0%
Total	**3,824,632**	**100%**	**6,482,426**	**100%**
% of Annual Sales Forecast	*9.9%*		*16.7%*	

Table 7-11: Commercial Achievable TRC Potential Demand Savings

Commercial Base Achievable Potential Savings Demand Savings		
	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,288**	**2,183**
% of Peak	*12.1%*	*20.2%*

7.1.3.2 Achievable UCT vs. Constrained UCT

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the Constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of Michigan annual utility revenues. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential.

Tables 7-12 and 7-13 show the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are just over 1 million MWh and under 2 million MWh respectively. This equates to 2.9% and 5.1% of sector sales in 2018 and 2023. The five and ten year demand savings estimates in the Constrained UCT scenario are depicted in Table 7-13.

Table 7-12: Commercial Constrained Achievable Energy Savings by End Use

Commercial Constrained Achievable Savings by End Use				
End Use	2018 Energy Savings (MWh)	% of 2018 Total	2023 Energy Savings (MWh)	% of 2023 Total
Lighting	401,766	36%	796,909	40%
Ventilation	145,569	13%	258,639	13%
Refrigeration	321,948	29%	521,837	26%
Other	25,481	2%	49,426	2%
Compressed Air	57,552	5%	87,943	4%
Space Cooling	18,841	2%	29,754	1%
Office Equipment	48,054	4%	94,863	5%
Space Heating	15,277	1%	22,684	1%
HVAC Controls	35,989	3%	52,997	3%
Water Heating	31,456	3%	50,074	3%
Building Envelope	1,346	0%	2,691	0%
Cooking	8,554	1%	17,592	1%
Pools	0	0%	0	0%
Total	**1,111,833**	**100%**	**1,985,411**	**100%**
% of Annual Sales Forecast	*2.9%*		*5.1%*	

Table 7-13: Commercial Constrained Achievable Demand Savings

Commercial Constrained Achievable Potential Savings Demand Savings		
	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	621	688
% of Peak	*5.8%*	*6.4%*

Figure 7-2 shows the estimated 10-year cumulative efficiency savings potential broken out by end use across the entire commercial sector for the Constrained UCT scenario. The lighting end use shows the largest potential for savings by a wide margin at just over 0.8 million MWh annually, or 40% of total savings, in the Constrained UCT scenario, with Refrigeration and Ventilation end uses accounting for 26% and 13% each.

Figure 7-2: Commercial Sector 2023 Constrained UCT Potential Savings by End Use

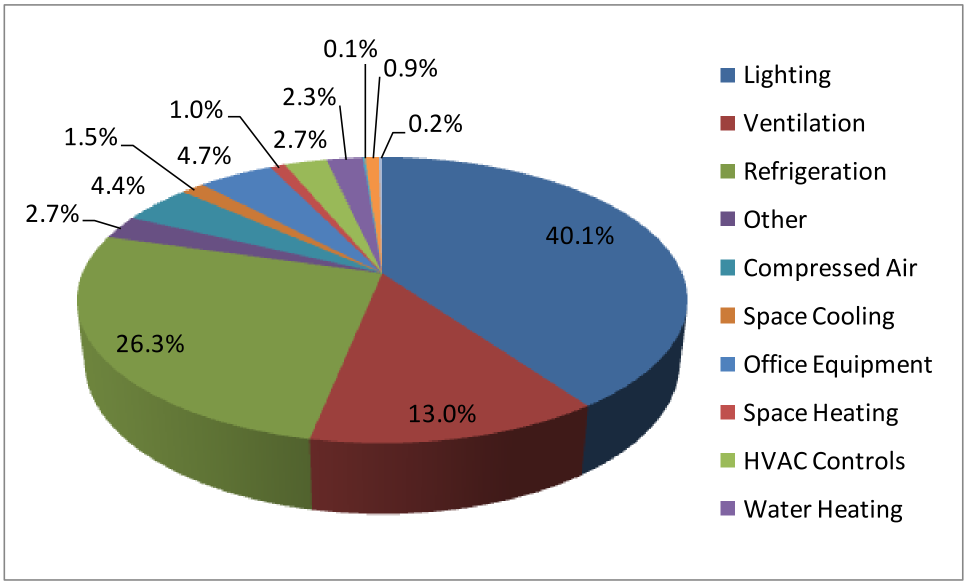
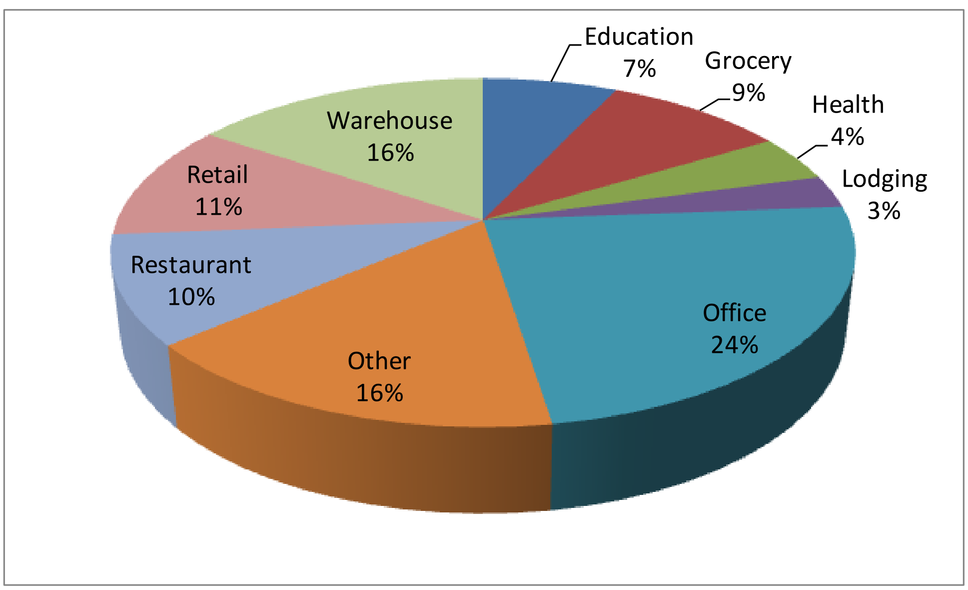


Figure 7-3 shows the breakdown of estimated savings in 2023 by building type for the Constrained UCT scenario. The vast majority of savings come from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed, with less than 1% of savings potential coming from new construction. More than 60% of the potential savings are found in four building types: Office, Warehouse, Retail and Restaurant.

Figure 7-3: Commercial Constrained UCT Savings in 2023 by Building Type



7.1.4 Annual Achievable Electric Savings Potential

Tables 7-14, Table 7-15 and Table 7-16 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 7-14: Cumulative Annual Commercial Energy Savings in the Achievable UCT Potential Scenario by End Use

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lighting	284,728	596,963	922,950	1,248,937	1,547,418	1,845,899	2,130,628	2,415,356	2,700,084	2,984,813
Ventilation	77,797	193,746	328,769	463,793	560,666	657,538	735,336	813,133	890,931	968,728
Refrigeration	129,772	390,907	717,724	1,044,541	1,239,995	1,435,449	1,565,220	1,694,992	1,824,764	1,954,536
Other	15,631	35,703	57,996	80,289	98,140	117,314	134,267	151,220	168,173	185,126
Compressed Air	18,698	65,878	127,300	188,723	221,662	254,601	273,298	291,996	310,694	329,391
Space Cooling	6,933	22,289	41,856	61,422	72,567	83,711	90,644	97,578	104,511	111,444
Office Equipment	33,674	71,062	110,307	149,552	185,083	220,613	254,287	287,961	321,634	355,308
Space Heating	4,407	16,993	33,668	50,344	58,840	67,336	71,743	76,149	80,556	84,963
HVAC Controls	10,009	39,700	79,232	118,765	138,615	158,465	168,473	178,482	188,491	198,500
Water Heating	11,911	37,510	69,954	102,398	121,154	139,909	151,819	163,730	175,641	187,552
Building Envelope	972	2,016	3,095	4,175	5,183	6,191	7,163	8,135	9,108	10,080
Cooking	6,589	13,178	19,768	26,357	32,946	39,535	46,124	52,714	59,303	65,892
Pools	0	0	0	0	0	0	0	0	0	0
Total	**601,121**	**1,485,945**	**2,512,620**	**3,539,295**	**4,282,267**	**5,026,561**	**5,629,004**	**6,231,446**	**6,833,889**	**7,436,332**
% of Annual Sales Forecast	***1.6%***	***3.9%***	***6.6%***	***9.3%***	***11.2%***	***13.1%***	***14.6%***	***16.2%***	***17.7%***	***19.2%***

Table 7-15: Cumulative Annual Commercial Energy Savings in the Achievable TRC Potential Scenario by End Use

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lighting	213,404	456,034	698,609	940,396	1,152,957	1,365,518	1,563,467	1,761,415	1,959,363	2,157,312
Ventilation	78,308	194,767	330,301	465,836	563,219	660,603	738,911	817,219	895,527	973,835
Refrigeration	127,636	386,201	710,232	1,034,263	1,227,363	1,420,464	1,548,099	1,675,735	1,803,370	1,931,006
Other	16,050	36,144	58,261	80,378	98,451	116,523	132,573	148,622	164,672	180,722
Compressed Air	18,646	65,672	126,888	188,104	220,940	253,776	272,422	291,068	309,714	328,360
Space Cooling	6,918	22,258	41,809	61,360	72,489	83,618	90,536	97,454	104,372	111,289
Office Equipment	33,391	70,496	109,458	148,421	183,669	218,917	252,308	285,699	319,090	352,481
Space Heating	277	554	831	1,108	1,385	1,663	1,940	2,217	2,494	2,771
HVAC Controls	10,009	39,700	79,232	118,765	138,615	158,465	168,473	178,482	188,491	198,500
Water Heating	10,573	33,857	63,496	93,135	110,063	126,991	137,564	148,137	158,711	169,284
Building Envelope	227	525	859	1,193	1,455	1,718	1,944	2,171	2,398	2,625
Cooking	5,859	11,717	17,576	23,435	29,293	35,152	41,011	46,869	52,728	58,586
Pools	1,215	3,131	5,398	7,665	9,231	10,797	12,011	13,226	14,441	15,656
Total	**522,511**	**1,321,057**	**2,242,952**	**3,164,058**	**3,809,131**	**4,454,203**	**4,961,259**	**5,468,315**	**5,975,371**	**6,482,426**
% of Annual Sales Forecast	***1.4%***	***3.5%***	***5.9%***	***8.3%***	***10.0%***	***11.6%***	***12.9%***	***14.2%***	***15.5%***	***16.7%***

Table 7-16: Cumulative Annual Commercial Energy Savings in Constrained UCT Potential Scenario by End Use

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lighting	76,019	159,382	246,416	333,451	401,766	492,833	568,852	644,871	720,890	796,909
Ventilation	20,771	51,728	87,777	123,827	145,569	175,555	196,326	217,097	237,868	258,639
Refrigeration	34,648	104,367	191,624	278,880	321,948	383,247	417,895	452,542	487,190	521,837
Other	4,173	9,532	15,484	21,436	25,481	31,321	35,848	40,374	44,900	49,426
Compressed Air	4,992	17,589	33,988	50,387	57,552	67,975	72,967	77,959	82,951	87,943
Space Cooling	1,851	5,951	11,175	16,399	18,841	22,350	24,201	26,052	27,903	29,754
Office Equipment	8,990	18,973	29,451	39,929	48,054	58,901	67,892	76,882	85,872	94,863
Space Heating	1,177	4,537	8,989	13,441	15,277	17,978	19,154	20,331	21,507	22,684
HVAC Controls	2,672	10,599	21,154	31,709	35,989	42,308	44,980	47,653	50,325	52,997
Water Heating	3,180	10,015	18,677	27,339	31,456	37,354	40,534	43,714	46,894	50,074
Building Envelope	260	538	826	1,115	1,346	1,653	1,912	2,172	2,432	2,691
Cooking	1,759	3,518	5,278	7,037	8,554	10,555	12,315	14,074	15,833	17,592
Pools	0	0	0	0	0	0	0	0	0	0
Total	**160,492**	**396,729**	**670,839**	**944,949**	**1,111,833**	**1,342,031**	**1,502,876**	**1,663,721**	**1,824,566**	**1,985,411**
% of Annual Sales Forecast	***0.4%***	***1.0%***	***1.8%***	***2.5%***	***2.9%***	***3.5%***	***3.9%***	***4.3%***	***4.7%***	***5.1%***

7.1.1 Commercial Electric Savings Summary by Measure Group

Table 7-17 below provides an end-use breakdown of the commercial electric savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained UCT potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 7-17 Electric Potential by End-Use and Measure

End Use	Technical Potential (MWh)	Economic UCT (MWh)	Economic TRC (MWh)	Achievable UCT (MWh)	Achievable TRC (MWh)	Constrained Achievable (MWh)
Lighting						
CFL Lighting Efficiency	339,900	339,900	238,451	180,504	121,103	50,693
Fluorescent Tube Lighting Efficiency	1,525,615	1,525,615	524,661	586,446	237,551	164,697
LED Lighting Efficiency	993,165	751,008	636,870	185,569	118,735	52,115
Other Lighting Efficiency	388,824	388,824	388,824	110,856	110,856	31,133
Lighting Controls and Design	3,089,000	3,069,487	3,091,479	1,554,684	1,569,067	436,615
Ventilation						
Controlled Ventilation Optimization	888,449	888,449	888,449	380,498	380,498	106,859
Destratification Fan	28,152	28,152	28,152	17,423	17,423	4,893
Electronically-Commutated Permanent Magnet Motors (ECPMs)	170,724	170,724	170,724	68,995	68,995	19,376
Enthalpy Economizer	279,316	0	0	0	0	0
High Performance Air Filters	554,183	554,183	554,183	63,142	63,142	17,733
Improved Duct Sealing	234,193	212,860	227,700	74,585	79,692	20,946
Variable Speed Drive Control	604,438	604,438	604,438	364,084	364,084	102,249
Refrigeration						
Commercial Ice-makers	26,532	0	0	0	0	0
Commercial Refrigerators/Freezers	93,160	93,160	58,023	51,181	31,879	14,373
Door Heater Controls	358,316	358,316	358,316	201,090	201,090	56,474
Efficient compressors	41,764	39,296	39,296	15,810	15,810	4,440
Fan motors & controls	1,073,482	1,062,801	1,055,550	584,646	580,311	164,191
Floating Head Pressure Control	79,686	79,686	79,686	52,245	52,245	14,672
Refrigerant charging correction	1,676	1,443	1,604	953	1,059	268
Refrigerated Case Covers	22,698	22,698	22,698	14,993	14,993	4,211
Refrigeration Economizer	14,256	0	0	0	0	0
Refrigeration Savings due to Lighting Savings	14,624	14,624	14,624	8,050	8,050	2,261
Refrigerator/Freezer Door Modifications	1,537,397	1,537,397	1,537,397	883,813	883,813	248,209
Vending Miser for Soft Drink Vending Machines	215,245	215,245	215,245	141,757	141,757	39,811
Other						
ECM motors on furnaces/Plug Fans	24,573	24,573	24,573	8,533	8,533	2,397

End Use	Technical Potential (MWh)	Economic UCT (MWh)	Economic TRC (MWh)	Achievable UCT (MWh)	Achievable TRC (MWh)	Constrained Achievable (MWh)
Energy Star Compliant Single Door Refrigerator	19,303	19,303	0	2,827	0	794
Engine Block Heater Timer	30,710	30,710	30,710	19,825	19,825	5,568
High Efficiency Pumps/VFD	22,330	22,330	22,330	10,790	10,790	3,030
NEMA Premium Transformer	531,700	531,700	531,700	113,135	113,135	31,773
Optimized Snow and Ice Melt Controls	44,049	44,049	44,049	28,437	28,437	7,986
Vendor Miser for Non-Refrig Equipment	24,813	24,813	0	15,971	0	4,485
Compressed Air						
Nozzles / Automatic Drains/Drop Filters/Flow Control	256,562	256,562	256,562	143,119	143,119	40,193
Barrel Wraps Injection Mold and Extruders	93,709	93,709	93,709	44,716	44,716	12,558
Compressed Air Audits & Leak Repair	155,844	155,844	155,844	100,609	100,609	28,255
Dryers/Receiver Capacity/Outdoor Air Intake	32,774	31,501	28,369	14,387	13,356	4,040
Efficient Air Compressors	81,772	81,772	81,772	26,103	26,103	7,331
Variable Displacement Air Compressor	1,011	1,011	1,011	457	457	128
Space Cooling						
Air-Cooled and Water-Cooled Chillers	72,219	72,219	72,219	15,532	15,532	4,362
Chilled Hot Water Reset	122,109	122,109	122,109	75,171	75,171	21,111
Ductless/GSHP/PTAC/WLHP	154,077	5,269	4,840	1,792	1,637	503
High Efficiency AC - Unitary & Split Systems	27,415	27,415	27,415	9,897	9,897	2,779
High Efficiency Pumps	51,758	51,758	51,758	9,052	9,052	2,542
Office Equipment						
Office Equipment	621,057	621,057	621,057	315,337	315,337	88,559
PC Network Energy Management Controls replacing no central control	75,238	75,238	75,238	37,143	37,143	10,431
"Smart" Power Strip/Monitor Power Management Software/UPS	217,415	0	0	0	0	0
Space Heating						
Ductless/GSHP/PTAC/WLHP	209,411	128,945	8,041	72,553	2,771	20,376
HVAC Controls						
EMS Installation / Optimization	239,210	239,210	239,210	147,259	147,259	41,356
Hotel Guest Room Occupancy Control System	2,836	2,836	2,836	1,676	1,676	471
Programmable Thermostats	92,486	92,486	92,486	49,564	49,564	13,920
Water Heating						
Booster Water Heater	6,783	0	0	0	0	0
Clothes Washer/Ozone Commercial Laundry	5,196	3,282	1,711	1,304	898	366
Dishwasher	3,509	3,509	3,509	1,289	1,289	362
Efficient Hot Water Pump	30,449	30,449	30,449	9,553	9,553	2,683

End Use	Technical Potential (MWh)	Economic UCT (MWh)	Economic TRC (MWh)	Achievable UCT (MWh)	Achievable TRC (MWh)	Constrained Achievable (MWh)
Heat Pump Water Heater	69,588	69,588	69,588	30,662	30,662	8,611
Heat Recovery	4,946	4,946	0	3,048	0	856
High Efficiency Electric Water Heater	18,579	18,579	18,579	9,428	9,428	2,648
Insulation	128,833	128,833	128,833	84,797	84,797	23,814
Low Flow Measures	77,391	77,391	77,391	28,186	28,186	7,916
Hot Water Circulation Pump Time-Clock	443	443	443	205	205	58
Point of Use Water Heating	1,506	0	0	0	0	0
Solar Water Heating System	7,486	7,486	7,486	4,267	4,267	1,198
Building Envelope						
Cool Roofing	291,735	0	0	0	0	0
Energy Efficient Windows	424,294	359,310	0	7,455	0	2,094
Integrated Building Design	10,624	10,624	10,624	1,911	1,911	537
Insulation	68,678	53,662	49,746	714	714	201
Cooking						
HE Oven	12,717	12,717	9,617	6,914	5,228	1,942
HE Fryer	6,356	0	0	0	0	0
HE Griddle	11,074	11,074	0	5,620	0	1,578
HE Holding Cabinet	37,962	37,962	37,962	19,850	19,850	5,575
HE Steamer	57,242	57,242	57,242	31,122	31,122	8,740
Induction Cooktops	4,024	4,024	4,024	2,386	2,386	670
Pools						
Energy Efficient Pool Pump with controls	14,857	14,857	14,857	8,513	8,513	2,391
Heat Pump Pool Heater	6,978	6,978	6,978	4,505	4,505	1,265
High efficiency spas/hot tubs	222	222	222	127	127	36
Solar Pool Heating	3,889	3,889	3,889	2,511	2,511	705
Total	**17,953,973**	**16,501,229**	**13,857,354**	**7,436,332**	**6,482,426**	**1,985,411**
% of Annual Sales Forecast	**46.29%**	**42.54%**	**35.73%**	**19.17%**	**16.71%**	**5.12%**
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the SCT Test.						

7.2 COMMERCIAL NATURAL GAS POTENTIAL

The GDS Associates natural gas consumption forecasts for the residential, commercial and industrial segments of the Michigan economy indicates that annual natural gas use will decrease by about 10% from 656.2 trillion BTU in 2013 to 587.2 trillion BTU in 2023.[34] Over that same period commercial natural gas use is expected to remain relatively stable varying annually between a range of 164.6 trillion BTU and 168.1 trillion BTU.

[34] GDS applied a forecast trends to actual deliveries by customer classes as reported by the U.S. Energy Information Administration (EIA). The annual sales forecast trends are based the EAI's Long term Reference Case forecast of natural gas consumption for the East North Central Region (Illinois, Indiana, Michigan, Ohio, and Wisconsin) as reported in the EIA 2013 Annual Energy Outlook.

7.2.1 Natural Gas Energy Efficiency Measures Examined

For the commercial sector, there were 86 unique natural gas savings measures included in the potential gas savings analysis. Table 7-18 provides a brief description of the types of natural gas energy efficiency measures included for each end use in the commercial sector. The list of measures was developed based on a review of the Michigan Energy Measures Database (MEMD), and measures found in other Technical Reference Manuals (TRMs) and measures listed in other commercial sector energy efficiency potential studies. For each measure, the analysis considered incremental costs, energy and demand savings, and useful measure life.

Table 7-18: Measures and Programs Included in the Commercial Sector Analysis

End Use Type	End Use Description	Measures Included
Building Envelope	Space Heating	• Building Envelope Improvements • Integrated Building Design
Cooking	Cooking Equipment Improvements	• Efficient Cooking Equipment
HVAC Controls	Space Heating	• EMS Installation/Optimization • Zoning • Commissioning & Retrocommissioning • Programmable Thermostats
Space Heating	Heating System Improvements	• Efficient Heating Equipment • Improved Duct Sealing • Pipe and Tank Insulation • Heating System Controls & Tune-up • Boiler Upgrades • Steam Trap Repair • Destratification Fans • Ventilation Controls • Heat Recovery • Thermostat Upgrades and Controls • Energy Recovery Ventilator
Space & Water Heating	Equipment Improvements	• High Efficiency Combined Space and Water Heating Equipment
Water Heating	Water Heating Improvements	• Efficient Water Heating Equipment • Heat Recovery Systems • Pipe Insulation & Pool Covers • Low Flow Equipment • Water Heater Controls & Tune-ups • Solar Water Heating System • Ozone Laundry System • Efficient Pool Heaters • Solar Pool Water Heater • Efficient HW Appliances

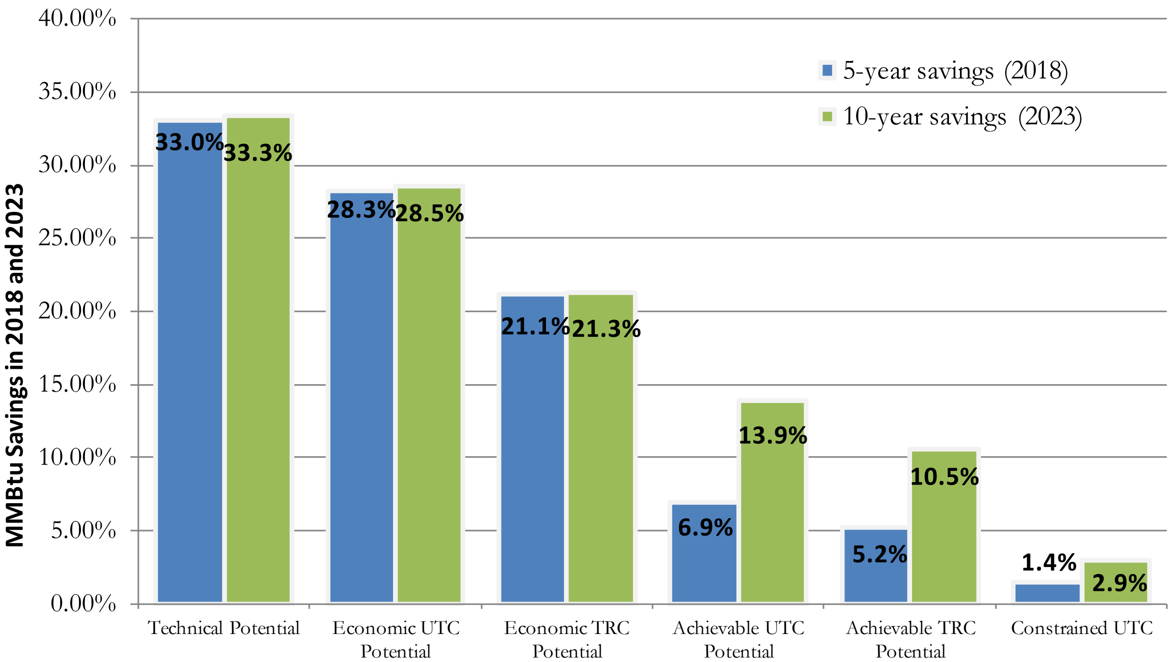
7.2.2 Technical and Economic Potential Natural Gas Savings

This section presents estimates for natural gas technical, economic, and achievable potential for the commercial sector (commercial and institutional combined). Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative annual savings (MMBtu) and percentage of forecast annual natural gas sales. Data is provided for a 5 and 10-year horizon for Michigan.

SUMMARY OF FINDINGS

Figure 7-4 illustrates the estimated energy efficiency savings potential for each of all the scenarios included in this study.

Figure 7-4: Summary of Commercial Natural Gas Energy Efficiency Potential as a % Sales Forecasts



The potential estimates are expressed as cumulative annual 5-year and 10-year savings, as percentages of the respective 2018 and 2023 commercial sector sales forecasts. The technical potential is 16.6% in 2018 and 33.3% in 2023. The 5-year and 10-year economic potential is 14.2% and 28.5% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 10.6% in 2018 and 21.3% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 6.9% and 13.9% for the Achievable UCT scenario; 5.2% and 10.5% for the Achievable TRC scenario; and 1.4% and 2.9% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual commercial and industrial revenue. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found.

TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 7-

19 shows that it is technically feasible to save more than 28.3 million MMBtu in the commercial sector between 2014 and 2018 and approximately 56.5 million MMBtu during the 10 year period from 2014 to 2023 across Michigan, representing approximately 17% of the commercial sales forecast for 2023, and 33% of 10-year commercial sales. HVAC Controls and Space Heating represent the majority of the potential at 30% and 29% of 10-yr savings, respectively, while cooking and space and water heating efficiency measures represent the smallest share each with 5% and 0% of 10-yr savings respectively.

Table 7-19: Commercial Sector Technical Potential MMBtu Savings by End Use

Commercial Technical Potential Savings by End Use				
End Use	2018 Energy Savings (MMBtu)	% of 2018 Total	2023 Energy Savings (MMBtu)	% of 2023 Total
Space Heating	16,253,289	29%	16,296,178	29%
Building Envelope	9,755,179	17%	9,834,760	17%
Water Heating	10,624,886	19%	10,654,040	19%
HVAC Controls	16,708,002	30%	16,746,400	30%
Space & Water Heating	49,645	0.1%	49,781	0.1%
Cooking	2,874,692	5%	2,882,580	5%
Total	56,265,693	100%	56,463,739	100%
Percent of Annual Sales Forecast	33.04%		33.35%	

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential only includes measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. Because the TRC includes participant costs as well as all utility costs, it goes beyond utility resource acquisition and looks at the measure/program from a broader perspective. 73% of all measures that were included in the natural gas potential analysis passed the UCT and 55% of all measures passed the TRC Test.

Table 7-20 indicates that the economic potential based on the UCT screen is nearly 24.2 million MMBtu by 2018, and the economic potential increases to 48.3 million MMBtu by 2023. This represents 14.2% and 28.5% of commercial sales across the respective 5-year and 10-year timeframes. HVAC Controls makes up a majority of the savings, followed very closely be Space Heating.

Table 7-20: Commercial Sector Economic Natural Gas UCT Savings by End Use

Commercial Economic Potential Savings by End Use				
End Use	2018 Energy Savings (MMBtu)	% of 2018 Total	2023 Energy Savings (MMBtu)	% of 2023 Total
Space Heating	14,406,233	30%	14,445,416	30%
Building Envelope	8,176,622	17%	8,250,840	17%
Water Heating	7,924,766	16%	7,946,510	16%
HVAC Controls	15,056,316	31%	15,090,642	31%

Commercial Economic Potential Savings by End Use				
Space & Water Heating	49,645	0%	49,781	0%
Cooking	2,518,210	5%	2,525,120	5%
Total	48,131,792	100%	48,308,309	100%
Percent of Annual Sales Forecast	28.27%		28.53%	

Table 7-21 shows that the economic potential based on the TRC screen is slightly more than 18 million MMBtu during the 5 year period from 2014 to 2018, and the economic potential increases to over 36 million MMBtu during the 10 year period from 2014 to 2023. This represents 10.6% and 21.3% of commercial sales across the respective 5-year and 10-year timeframes. Again Space Heating and HVAC Controls make up the majority of the Economic TRC savings with Space Heating representing the largest economic TRC potential.

Table 7-21: Commercial Sector Economic Natural Gas TRC Savings by End Use

Commercial Economic Potential Savings by End Use				
End Use	**2018 Energy Savings (MMBtu)**	**% of 2018 Total**	**2023 Energy Savings (MMBtu)**	**% of 2023 Total**
Space Heating	14,078,787	39%	14,117,523	39%
Building Envelope	2,069,890	6%	2,069,890	6%
Water Heating	5,908,352	16%	5,924,564	16%
HVAC Controls	12,465,286	35%	12,499,612	35%
Space & Water Heating	49,645	0%	49,781	0%
Cooking	1,432,974	4%	1,436,906	4%
Total	36,004,934	100%	36,098,275	100%
Percent of Annual Sales Forecast	21.15%		21.32%	

7.2.1 Achievable Potential Savings in the Commercial Sector

Achievable potential is an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles. This study estimated achievable potential for three scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. Unlike the economic potential, the commercial achievable potential takes into account the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment. The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

7.2.1.1 UCT vs. TRC

Tables 7-22 and 7-23 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years.

Overall the Achievable UCT scenario results in an achievable potential that is 5.7 MMBtu greater, over the next decade, than the achievable TRC scenario.

Table 7-22: Commercial Achievable UCT Natural Gas Potential Savings by End Use

Commercial UCT Natural Gas Savings by End Use				
End Use	**2018 Energy Savings (MMBtu)**	**% of 2018 Total**	**2023 Energy Savings (MMBtu)**	**% of 2023 Total**
Space Heating	2,894,675	25%	5,789,350	25%
Building Envelope	1,570,023	13%	3,140,047	13%
Water Heating	1,848,508	16%	3,697,016	16%
HVAC Controls	4,552,963	39%	9,105,927	39%
Space & Water Heating	18,769	0%	37,538	0%
Cooking	851,186	7%	1,702,372	7%
Total	11,736,125	100%	23,472,249	100%
Percent of Annual Sales Forecast	6.89%		13.86%	

Table 7-23 Commercial Achievable TRC Natural Gas Potential Savings by End Use

Commercial TRC Natural Gas Savings by End Use				
End Use	**2018 Energy Savings (MMBtu)**	**% of 2018 Total**	**2023 Energy Savings (MMBtu)**	**% of 2023 Total**
Space Heating	2,771,894	31%	5,543,788	31%
Building Envelope	393,354	4%	786,708	4%
Water Heating	1,496,576	17%	2,993,153	17%
HVAC Controls	3,750,457	42%	7,500,913	42%
Space & Water Heating	18,769	0%	37,538	0%
Cooking	478,969	5%	957,937	5%
Total	8,910,018	100%	17,820,037	100%
Percent of Annual Sales Forecast	5.23%		10.52%	

7.2.1.2 Achievable UCT vs. Constrained UCT

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the Constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of Michigan annual utility revenue. The percent of the non-residential spending cap allocated to the commercial sector is based on the percentage of total non-residential UCT savings that the commercial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential.

Table 7-24 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are approximately 2.4

million MMBtu and 4.9 million MMBtu. This equates to 1.41% and 2.92% of sector sales in 2018 and 2023.

Table 7-24: Commercial Constrained UCT Natural Gas Achievable Energy Savings by End Use

Commercial Constrained Achievable Natural Gas Savings by End Use				
End Use	**2018 Energy Savings (MMBtu)**	**% of 2018 Total**	**2023 Energy Savings (MMBtu)**	**% of 2023 Total**
Space Heating	592,457	25%	1,219,090	25%
Building Envelope	321,339	13%	661,214	13%
Water Heating	378,337	16%	778,498	16%
HVAC Controls	931,862	39%	1,917,477	39%
Space & Water Heating	3,841	0%	7,905	0%
Cooking	174,214	7%	358,476	7%
Total	2,402,050	100%	4,942,660	100%
Percent of Annual Sales Forecast	1.41%		2.92%	

Figure 7-5 shows the estimated 10-year cumulative natural efficiency savings potential broken out by end use across the entire commercial sector. HVAC Controls show the largest potential for savings at just under 2 million MMBtu, or 39% of total savings, in the Constrained UCT Achievable scenario.

Figure 7-5: Commercial Sector 2023 Constrained UCT Achievable Potential Savings by End Use

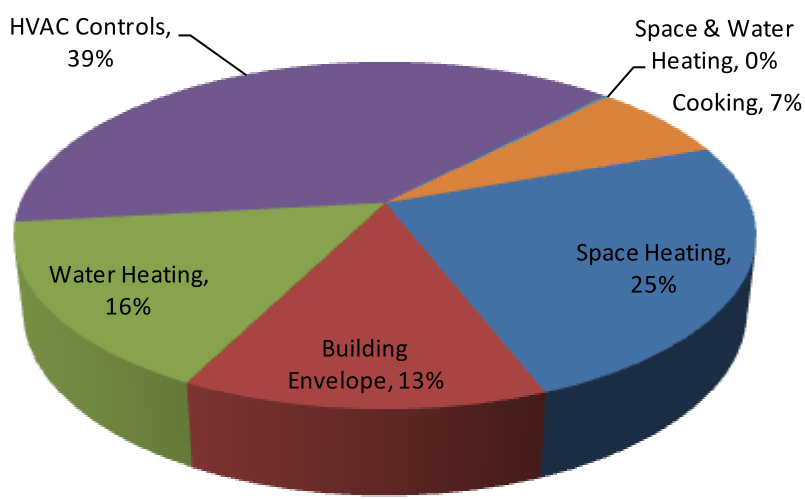
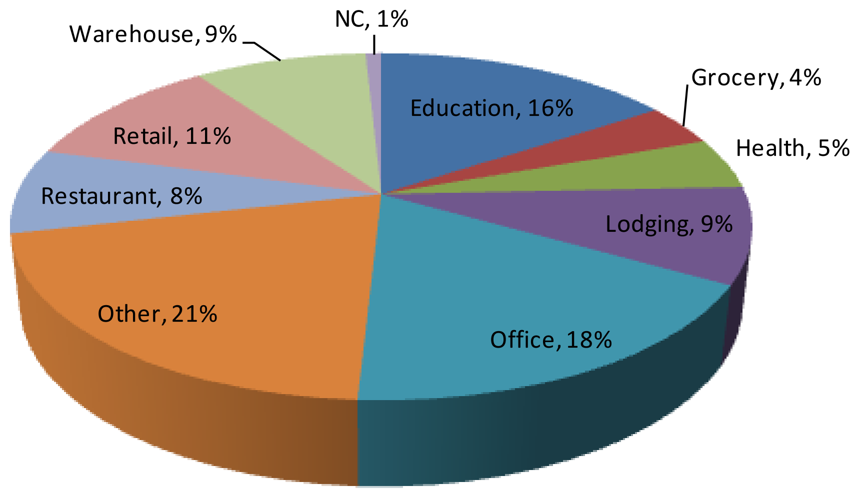


Figure 7-6 shows the breakdown of estimated natural gas savings in 2023 by building type for the Constrained UCT Achievable scenario. The vast majority of savings come from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed, with about 1% of savings potential coming from new construction. The 'Offices' and 'Other' categories represent the largest potential savings at 18% and 21% respectively.

Figure 7-6: Commercial Constrained UCT Achievable Potential Savings in 2023 by Building Type



Tables 7-25, Table 7-26 and Table 7-27 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 7-25: Cumulative Annual Commercial Natural Gas Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Space Heating	578,935	1,157,870	1,736,805	2,315,740	2,894,675	3,473,610	4,052,545	4,631,480	5,210,415	5,789,350
Building Envelope	314,005	628,009	942,014	1,256,019	1,570,023	1,884,028	2,198,033	2,512,037	2,826,042	3,140,047
Water Heating	369,702	739,403	1,109,105	1,478,806	1,848,508	2,218,209	2,587,911	2,957,612	3,327,314	3,697,016
HVAC Controls	910,593	1,821,185	2,731,778	3,642,371	4,552,963	5,463,556	6,374,149	7,284,741	8,195,334	9,105,927
Space & Water Heating	3,754	7,508	11,261	15,015	18,769	22,523	26,277	30,030	33,784	37,538
Cooking	170,237	340,474	510,712	680,949	851,186	1,021,423	1,191,661	1,361,898	1,532,135	1,702,372
Total	**2,347,225**	**4,694,450**	**7,041,675**	**9,388,900**	**11,736,125**	**14,083,350**	**16,430,575**	**18,777,799**	**21,125,024**	**23,472,249**
% of Annual Sales Forecast	***1.4%***	***2.7%***	***4.1%***	***5.5%***	***6.9%***	***8.3%***	***9.7%***	***11.1%***	***12.5%***	***13.9%***

Table 7-26: Cumulative Annual Commercial Natural Gas Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Space Heating	554,379	1,108,758	1,663,136	2,217,515	2,771,894	3,326,273	3,880,652	4,435,030	4,989,409	5,543,788
Building Envelope	78,671	157,342	236,012	314,683	393,354	472,025	550,696	629,366	708,037	786,708
Water Heating	299,315	598,631	897,946	1,197,261	1,496,576	1,795,892	2,095,207	2,394,522	2,693,837	2,993,153
HVAC Controls	750,091	1,500,183	2,250,274	3,000,365	3,750,457	4,500,548	5,250,639	6,000,731	6,750,822	7,500,913
Space & Water Heating	3,754	7,508	11,261	15,015	18,769	22,523	26,277	30,030	33,784	37,538
Cooking	95,794	191,587	287,381	383,175	478,969	574,762	670,556	766,350	862,143	957,937
Total	**1,782,004**	**3,564,007**	**5,346,011**	**7,128,015**	**8,910,018**	**10,692,022**	**12,474,026**	**14,256,030**	**16,038,033**	**17,820,037**
% of Annual Sales Forecast	***1.1%***	***2.1%***	***3.1%***	***4.2%***	***5.2%***	***6.3%***	***7.4%***	***8.4%***	***9.5%***	***10.5%***

Table 7-27: Cumulative Annual Commercial Natural Gas Savings in Constrained Achievable Potential Scenario by End Use for Michigan

End Use	2013	2014	2015	2016	2018	2018	2019	2020	2021	2023
Space Heating	117,881	234,584	352,104	471,395	592,457	715,052	839,466	965,536	1,091,443	1,219,090
Building Envelope	63,937	127,235	190,975	255,677	321,339	387,832	455,312	523,691	591,980	661,214
Water Heating	75,278	149,803	224,850	301,028	378,337	456,624	536,074	616,581	696,984	778,498
HVAC Controls	185,412	368,972	553,816	741,446	931,862	1,124,688	1,320,376	1,518,668	1,716,704	1,917,477
Space & Water Heating	764	1,521	2,283	3,057	3,841	4,636	5,443	6,261	7,077	7,905
Cooking	34,663	68,980	103,537	138,615	174,214	210,263	246,847	283,918	320,941	358,476
Total	**477,936**	**951,095**	**1,427,564**	**1,911,218**	**2,402,050**	**2,899,095**	**3,403,519**	**3,914,655**	**4,425,129**	**4,942,660**
% of Annual Sales Forecast	***0.3%***	***0.6%***	***0.8%***	***1.1%***	***1.4%***	***1.7%***	***2.0%***	***2.3%***	***2.6%***	***2.9%***

7.2.1 Commercial Savings Summary

Table 7-28 provides an end-use breakdown of the commercial natural gas savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained Achievable potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 7-28: Natural Gas Potential by End-Use and Measure

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBTu)	Achievable Potential -TRC- (MMBTu)	Constrained Achievable –UCT- (MMBTu)
Building Envelope						
Energy Efficient Windows	3,447,116	4,763,745	0	1,475,451	0	310,692
Greenhouse Curtains/Film	2,202,725	157,705	157,705	97,691	97,691	20,571
Insulation Upgrades	3,671,644	3,180,955	1,912,185	1,474,957	689,017	310,589
Integrated Building Design	147,837	148,435	0	91,948	0	19,362
Truck Loading Dock Seals	365,438	0	0	0	0	0
Space Heating						
Boiler Modifications/Controls	2,622,377	1,166,577	1,045,633	471,804	434,345	99,350
Condensing Boiler & Efficiency Improvements	1,012,077	0	0	0	0	0
Demand Controlled Ventilation	5,645,088	5,667,118	5,667,118	2,309,509	2,309,509	486,324
Destratification Fans	1,636,388	1,643,202	2,030,198	678,588	838,404	142,893
Gas Furnace	1,003,319	1,003,319	1,003,319	414,337	414,337	87,249
Gas Unit Heater	534,530	534,530	534,530	174,271	174,271	36,697
Guest Room Energy Management	433,856	593,945	0	367,919	0	77,474
Heat Recovery/ERV	145,479	0	0	0	0	0
Infrared Heater	107,083	107,083	107,083	44,222	44,222	9,312
Makeup Air	1,051,834	1,055,950	1,055,950	327,054	327,054	68,869
Pipe Insulation/Duct Sealing	2,292,648	2,292,648	2,292,648	824,018	824,018	173,517
Tune-up/Steam Trap Repair	169,638	169,638	169,638	105,082	105,082	22,128
HVAC Controls						
Commissioning/Retrocommissioning	2,041,791	0	0	0	0	0
EMS Install/Optimization	8,789,992	8,550,221	8,550,221	5,054,463	5,054,463	1,064,342
Programmable Thermostat	3,934,044	3,949,391	3,949,391	2,446,450	2,446,450	515,160
Zoning	1,980,573	2,591,030	0	1,605,013	0	337,975
Cooking						
High Efficiency Fryer	719,773	719,773	0	479,849	0	101,044
High Efficiency Gas Broiler	69,879	69,879	0	46,586	0	9,810
High Efficiency Gas Ovens	467,512	266,094	109,725	177,396	73,150	37,355
High Efficiency Gas Griddle	156,043	0	0	0	0	0

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBTu)	Achievable Potential -TRC- (MMBTu)	Constrained Achievable –UCT- (MMBTu)
High Efficiency Gas Steamer	1,327,180	1,327,180	1,327,180	884,787	884,787	186,314
Power Burner Range	142,194	142,194	0	113,755	0	23,954
Water Heating						
Circulation Pump Time Clocks	749,404	749,404	749,404	507,684	507,684	106,905
Clothes Washer ENERGY STAR	158,429	0	100,427	0	68,034	0
Stand Alone Commercial Water Heaters	528,073	150,287	150,287	78,317	78,317	16,491
ES Dishwasher	428,304	428,304	428,304	178,557	178,557	37,600
Heat Recovery Water Heater/GFX	1,749,681	1,749,681	826,811	686,015	373,415	144,457
Indirect Water Heaters	469,375	469,375	0	211,985	0	44,639
Low Flow Aerators/Showerheads/Nozzles	1,036,297	1,036,297	1,036,297	702,039	702,039	147,832
On-Demand, Tankless Water Heater	1,963,692	957,965	742,776	324,487	251,597	68,329
Ozone Laundry System/Generator	718,309	718,309	718,309	331,061	331,061	69,713
Pipe wrap/Tune-up	496,976	219,165	219,165	74,237	74,237	15,632
Pool Measures (including Solar)	952,784	952,784	952,784	428,212	428,212	90,171
Solar Water Heating	887,777	0	0	0	0	0
Wastewater, Filtration/Reclamation	514,939	514,939	0	174,423	0	36,729
Space & Water Heating						
Combination Water Heater/Boiler	45,063	45,063	45,063	35,022	35,022	7,375
Combination Water Heater/Furnace	4,718	4,718	4,718	2,516	2,516	530
Total	56,463,739	48,308,309	35,997,848	23,472,249	17,752,003	4,942,660
% of Annual Sales Forecast	33%	29%	21%	14%	11%	3%
Note: Measures in the Table with "0" in the Economic or Achievable Potentials are ones that did not pass the TRC or UCT.						

7.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

The tables below provide the net present value (NPV) benefits and costs associated with the three achievable potential scenarios for the commercial sector at the 5-year and 10-year periods. Tables 7-29 and 7-30 compare the 5 and 10 year NPV benefits and costs associated with the Achievable UCT and Achievable TRC Scenarios. Both the UCT and TRC scenario benefits include avoided energy supply and demand costs, while the Achievable TRC scenario benefits also include water savings benefits, and carbon tax adder. The NPV costs in the Achievable UCT scenario includes only program administrator costs (incentives paid, staff labor, marketing, etc.) whereas the Achievable TRC scenario costs include both participant and program administrator costs.

Table 7-29: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Commercial Sector Only

5-year	NPV Benefits	NPV Costs	B/C Ratio
Achievable UCT	$7,115,749,853	$1,621,295,240	4.39
Achievable TRC	$7,259,482,599	$1,650,043,090	4.40

Table 7-30: 10-Year Benefit-Cost Ratios for Achievable Potential Scenarios– Commercial Sector Only

10-year	NPV Benefits	NPV Costs	B/C Ratio
Achievable UCT	$12,606,435,598	$2,699,563,424	4.67
Achievable TRC	$12,803,543,479	$2,720,070,075	4.71

Tables 7-31 and 7-32 compare the NPV benefits and costs associated with the Achievable UCT and Constrained UCT Scenarios. Both scenarios compared the benefits and costs based the UCT. However the constrained scenario's 2% of revenue spending cap on DSM results in reduced program participation and overall NPV benefits.

Table 7-31: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Commercial Sector Only

5-year	NPV Benefits	NPV Costs	B/C Ratio
Achievable UCT	$7,115,749,853	$1,621,295,240	4.39
Constrained UCT	$1,770,712,843	$397,875,475	4.45

Table 7-32: 10-Year Benefit-Cost Ratios for Achievable Potential Scenarios– Commercial Sector Only

10-year	NPV Benefits	NPV Costs	B/C Ratio
Achievable UCT	$12,606,435,598	$2,699,563,424	4.67
Constrained UCT	$3,406,602,047	$712,346,058	4.78

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Tables 7-33 through 7-35.

Table 7-33: Year By Year Budgets for Achievable Potential TRC Scenarios– Commercial Sector Only

Year By Year Budgets for Achievable TRC Scenario (in $1,000,000)										
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Admin	$ 47.0	$ 63.4	$ 71.7	$ 71.9	$ 58.2	$ 59.5	$ 51.9	$ 52.3	$ 54.7	$ 55.7
Incentive	$117.6	$158.5	$179.2	$179.7	$145.6	$148.7	$129.8	$130.7	$136.7	$139.2
Total	$164.6	$221.9	$250.9	$251.6	$203.8	$208.1	$181.7	$183.0	$191.4	$194.9

Table 7-34: Year By Year Budgets for Achievable Potential UCT Scenarios– Commercial Sector Only

Year By Year Budgets for Achievable UCT Scenario (in $1,000,000)										
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Admin	$ 84.4	$106.5	$117.7	$117.9	$ 98.6	$100.4	$ 91.2	$ 92.0	$ 94.8	$ 95.2
Incentive	$211.1	$266.3	$294.2	$294.7	$246.4	$250.9	$227.9	$229.9	$237.1	$237.9
Total	$295.5	$372.8	$411.9	$412.6	$345.0	$351.3	$319.1	$321.9	$331.9	$333.1

Table 7-35: Year By Year Budgets for Cost Constrained UCT Scenarios– Commercial Sector Only

Year By Year Budgets for Cost Constrained UCT Scenario (in $1,000,000)										
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Admin	$ 25.0	$ 25.3	$ 25.7	$ 26.0	$ 26.4	$ 26.8	$ 27.3	$ 27.7	$ 28.1	$ 28.6
Incentive	$ 62.5	$ 63.2	$ 64.2	$ 65.1	$ 66.1	$ 67.1	$ 68.2	$ 69.2	$ 70.3	$ 71.4
Total	$ 87.6	$ 88.5	$ 89.8	$ 91.1	$ 92.5	$ 94.0	$ 95.4	$ 96.9	$ 98.4	$100.0

8 INDUSTRIAL SECTOR ELECTRIC AND NATURAL GAS ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides electric and natural gas energy efficiency potential estimates for the industrial sector in Michigan. Estimates of technical, economic and achievable potential are provided in separate sections for electric and natural gas.

8.1 INDUSTRIAL ELECTRIC ENERGY EFFICIENCY POTENTIAL

According to 2012 historical sales data[35], the industrial sector accounts for approximately 30% of retail electric sales in Michigan. This sector is dominated by the transportation equipment industry which represents almost 25% of industrial electric retail sales. Other key industrial sectors are primary metals and chemicals. Industrial kWh sales over the period 2002 to 2012 reached their highest level in 2003 of almost 40,000 GWh and their lowest level in 2009 of about 27,000 GWh. Since 2009 Industrial sales have rebounded, increasing by 14% to 31,306 GWh in 2012. For this study, industrial electric sales are forecast to continue to increase reaching a level of almost 35,000 GWh in 2023, which represents a compound annual growth rate of slightly less than 1%[36]

8.1.1 Electric Energy Efficiency Measures Examined

For the industrial sector, there were 152 unique energy efficiency measures included in the energy savings potential analysis. Table 8-1 provides a brief description of the types of measures included for each end use in the industrial sector. The list of measures was developed based on a review of the Michigan Energy Measures Database (MEMD), and measures found in other Technical Reference Manuals (TRMs) and industrial potential studies. For each measure, the analysis considered incremental costs, energy and demand savings, and measure useful measure lives.

Table 8-1: Types of Electric Measures Included in the Industrial Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
Building Envelope	Building Envelope Improvements	• Wall Insulation R-7.5 to R13 • Integrated Building Design • Below Grade Insulation • Ceiling Insulation R-11 to R-42 • Roof Insulation R-11 to R-24
Computers & Office Equipment	Equipment Improvements	• Energy Star Office equipment including computers, monitors, copiers, multi-function machines • PC Network Energy Management Controls replacing no central control • Energy Star Compliant Single Door Refrigerator
Cooking	Cooking Equipment Improvements	• HE Steamer • HE Holding Cabinet • HE Combination Oven • Induction Cooktops
HVAC Controls	HVAC Control Improvements	• EMS Optimization • EMS install • Programmable Thermostats
Lighting	Lighting Improvements	• Lighting Power Density - Exceed Code

[35] U.S. Energy Information Administration

[36] GDS forecast based on sales forecasts provided by DTE and CE and historical industrial sales trends for the state as a whole.

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		by 10% • CFL Screw in Specialty • Occupancy Sensors for LED Refrigerator • Lighting • CFL Screw-in • LED Exit Sign • 30% More Efficient Design - New Construction • 15% More Efficient Design - New Construction • CFL Fixture • CFL Flood • LED Pin Based Lamp • LED Screw In • Daylight Dimming - New Construction • HID Fixture Upgrade - Pulse Start Metal Halide • Central Lighting Control • Daylight Dimming • High Intensity Fluorescent Fixture (replacing HID) • Stairwell Bi-Level Control • LED Wallpack • Remote Mounted Occupancy Sensor • Switching Controls for Multilevel Lighting (Non-HID) • LED Replacing Halogen Incandescent Controls for H.I.F. • New Fluorescent Fixtures T5/HP T8 reduced wattage (replacing T8) • Induction Fluorescent • LED Downlight • Fluorescent Fixture with Reflectors • Lamp & Ballast Retrofit (HPT8 Replacing T12) • Lamp & Ballast Retrofit (Low Wattage HPT8 Replacing Standard T8) • CFL Exterior Lighting • Parking Garage LED • LED Lighting in Refrigeration • LED Outdoor Area Fixture (Parking Light or Street Light) • T5 HP replacing T12 • Switch Mounted Occupancy Sensor • Illuminated Signs to LED • 42W 8 lamp Hi Bay CFL • Light Tube • Lamp & Ballast Retrofit (HPT8 Replacing Standard T8) • New Fluorescent Fixtures T5/HP T8

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		(replacing T12)
Machine Drive	Machine Drive Improvements	• Compressed Air - Advanced Compressor Controls • Advanced Lubricants • Compressed Air System Management • Pump System Efficiency Improvements • Motor System Optimization (Including ASD) • Electric Supply System Improvements • Sensors & Controls • Fan System Improvements • Advanced Efficient Motors • Industrial Motor Management • Energy Information System
Other		• NEMA Premium Transformer, three-phase • NEMA Premium Transformer, single-phase
Process Cooling and Refrigeration	Process Cooling and Refrigeration Improvements	• Improved Refrigeration • Electric Supply System Improvements • Sensors & Controls • Energy Information System
Process Heating	Heating Improvements	• Electric Supply System Improvements • Sensors & Controls • Energy Information System
Refrigeration	Refrigeration Improvements	• H.E. Evaporative Fan Motors • Floating Head Pressure Control • ECM case fan motors • ENERGY STAR Commercial Glass Door Freezers • Refrigerated Case Covers • Automatic High Speed Doors - between freezer and cooler • Door Heater Controls • Zero-Energy Doors • ENERGY STAR Commercial Solid Door Freezers • Refrigerant charging correction • Vending Miser for Soft Drink Vending Machines • Discus and Scroll Compressors • Reach-in Refrigerated display case door retrofit • Evaporator Fan Motor Controls on S-P motors • ENERGY STAR Commercial Glass Door Refrigerators • Evaporator Fan Motor Controls on PSC motors • Refrigeration Economizer

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		• ENERGY STAR Commercial Solid Door Refrigerators
Space Cooling - Chillers	Cooling System Upgrades	• Efficient Chilled water Pump • Chilled Hot Water Reset • Water-Cooled Screw Chiller > 300 ton • Air-Cooled Recip Chiller • Water-Cooled Centrifugal Chiller > 300 ton • Air-Cooled Screw Chiller • Water-Cooled Screw Chiller 150 – 300 ton • Water-Cooled Centrifugal Chiller 150 – 300 ton • Water-Cooled Screw Chiller < 150 ton • Water-Cooled Centrifugal Chiller < 150 ton • High Efficiency Pumps
Space Cooling – Unitary and Split AC	Cooling System Upgrades	• Water Loop Heat Pump (WLHP) – Cooling • High Efficiency AC – Unitary & Split Systems • Ductless (mini split) – Cooling • Ground Source Heat Pump - Cooling
Space Heating	Heating System Improvements	• VFD Pump • High Efficiency Pumps • Water Loop Heat Pump (WLHP) - Heating • Ground Source Heat Pump – Heating • Ductless (mini split) – Heating
Ventilation	Ventilation Equipment	• Electronically-Commutated Permanent Magnet Motors (ECPMs) • Demand-Controlled Ventilation • High Performance Air Filters • Variable Speed Drive Control, 15 HP • Variable Speed Drive Control, 5 HP • Variable Speed Drive Control, 40 HP • Controlled Ventilation Optimization • Improved Duct Sealing • Destratification Fan
Water Heating	Water Heating Improvements	• Low Flow Faucet Aerator • Tank Insulation (electric) • ES Dishwasher, Low Temp, Elec Heat • Heat Pump Water Heater • Efficient Hot Water Pump • ES Dishwasher, High Temp, Elec Heat, Elec Booster • Hot Water Circulation Pump Time-Clock • ES Dishwasher, High Temp, Gas Heat, Elec Booster • Hot Water (DHW) Pipe Insulation • High Efficiency Electric Water Heater • ES Dishwasher, High Temp, Gas Heat, Gas Booster • Solar Water Heating System • Drain Water Heat Recovery Water Heater • Point of Use Water Heating

END USE TYPE	END USE DESCRIPTION	MEASURES INCLUDED
		• ES Dishwasher, Low Temp, Gas Heat

8.1.2 Technical and Economic Potential Electric Savings

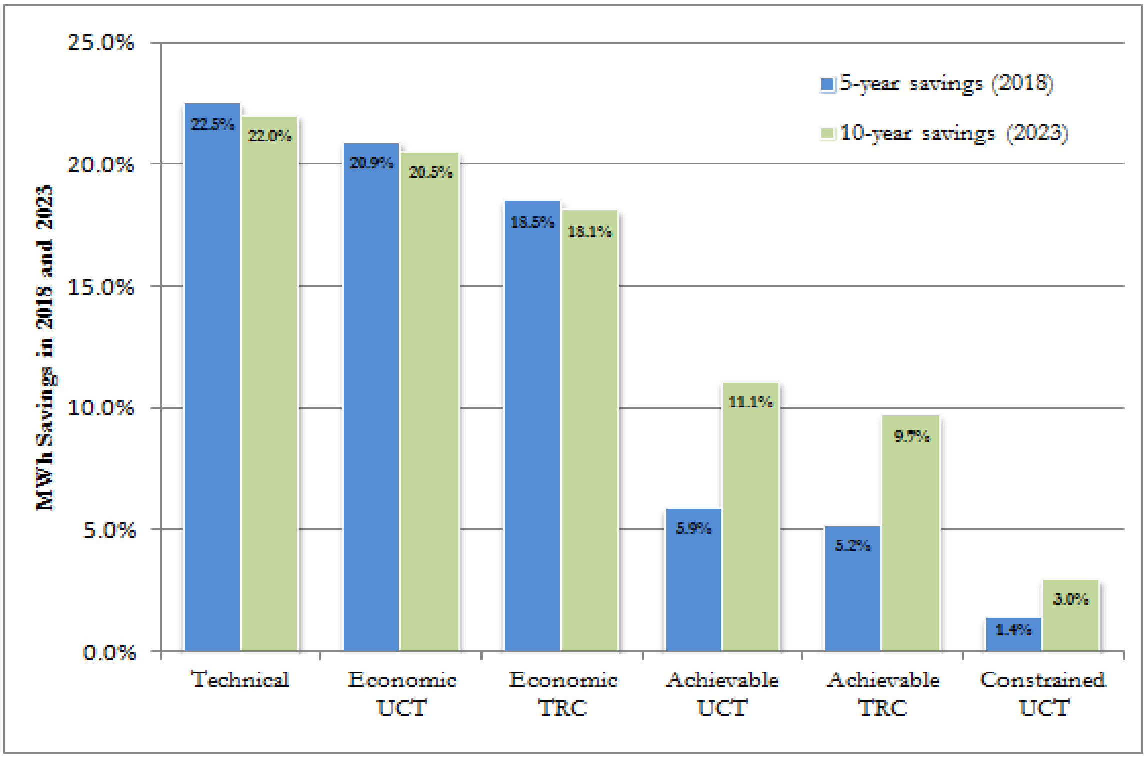
This section presents estimates for electric technical, economic, and achievable savings potential for the industrial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for energy efficiency savings expressed as cumulative annual savings (MWh) and percentage of annual kWh sales. Data is provided for a 5 and 10-year horizon for Michigan

This energy efficiency potential study considers the impacts of the December 2007 Energy and Independence and Security Act (EISA) as an improving code standard for the industrial sector. EISA improves the baseline efficiency of compact fluorescent lamps (CFL), general service fluorescent lamps (GSFL), high intensity discharge (HID) lamps and ballasts and motors, all applicable in the industrial sector.

SUMMARY OF FINDINGS

Figure 8-1 illustrates the estimated savings potential in Michigan for each of the scenarios included in this study.

Figure 8-1: Summary of Industrial Electric Energy Efficiency Potential as a % of Sales Forecasts



The potential estimates are expressed as cumulative annual 5-year and 10-year savings, as percentages of the respective 2018 and 2023 forecasts for industrial sector sales. The technical potential is 22.5% in 2018 and 22.0% in 2023. The 5-year and 10-year economic potential is: 20.9% and 20.5% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 18.5% in 2018 and 18.1% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 5.9% and 11.1% for the Achievable UCT scenario; 5.2% and 9.7% for the Achievable TRC scenario; and 1.4% and 3.0% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual industrial and industrial revenue. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will allocated at the sector level based on where the savings opportunities are found.

TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 8-2 shows that it is technically feasible to save more than 7.6 million MWh in the industrial sector during the 10 year period from 2014 to 2023 across Michigan, representing 22.5% of 5-year industrial sales and 22.0% of 10-year industrial sales. Machine Drive represents the majority of the potential at 42% of 10-yr savings, while water heating, cooking, space heating and refrigeration represent the smallest shares, each with less than 1 percent of 10-yr savings. Table 8-3 shows the annual (summer) peak demand savings potential in 2018 and 2023. The ten year summer peak demand savings potential is 1,430 MW, which is 32.4% of the 5-year peak forecast and 31.5% of the 10-year peak forecast.

Table 8-2: Industrial Sector Technical Potential Savings By End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Machine Drive	3,197,326	42%	3,197,326	42%
Lighting	2,402,094	31%	2,402,094	31%
Ventilation	620,719	8%	620,719	8%
Process	506,978	7%	506,978	7%
Space Cooling	343,412	4%	343,412	4%
Other	140,592	2%	140,592	2%
HVAC Controls	108,073	1%	108,073	1%
Envelope	97,762	1%	97,762	1%
Office Equipment	90,982	1%	90,982	1%
Space Heating	51,725	1%	51,725	1%
Water Heating	45,019	1%	45,019	1%
Refrigeration	30,685	0%	30,685	0%
Cooking	5,005	0%	5,005	0%
Total	**7,640,370**	**100%**	**7,640,370**	**100%**
% of Annual Sales Forecast	*22.5%*		*22.0%*	

Table 8-3: Industrial Sector Technical Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,430**	**1,430**
% of Peak	*32.4%*	*31.5%*

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. The TRC Test was also included because it also considers the cost assumed by the participant. 89% of all measures that were included in the electric potential analysis passed the UCT and 89% of all measures passed the TRC Test.

Table 8-4 indicates that the economic potential based on the UCT screen is slightly more than 7.1 million MWh during the 10 year period from 2014 to 2023. This represents 20.9% and 20.5% of industrial sales across the respective 5-year and 10-year timeframes. Machine drive, lighting and process make up a majority of the savings. Table 8-5 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 1,401 MW, respectively, which is 31.7% and 30.9% of the 5-year and 10-year peak forecasts.

Table 8-4: Industrial Sector Economic Potential (UCT) Savings By End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Machine Drive	3,197,326	45%	3,197,326	45%
Lighting	2,238,689	31%	2,238,689	31%
Process	506,978	7%	506,978	7%
Ventilation	417,217	6%	417,217	6%
Space Cooling	225,139	3%	225,139	3%
Other	140,592	2%	140,592	2%
HVAC Controls	108,073	2%	108,073	2%
Space Heating	84,947	1%	84,947	1%
Office Equipment	59,271	1%	59,271	1%
Envelope	58,214	1%	58,214	1%
Water Heating	44,993	1%	44,993	1%
Refrigeration	30,548	0%	30,548	0%
Cooking	4,231	0%	4,231	0%
Total	**7,116,215**	**100%**	**7,116,215**	**100%**
% of Annual Sales Forecast	*20.9%*		*20.5%*	

Table 8-5: Industrial Sector Economic Potential (UCT) Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,401**	**1,401**
% of Peak	*31.7%*	*30.9%*

Table 8-6 shows that the economic potential based on the TRC screen is over 6 million MWh during the 10 year period from 2014 to 2023. This represents 18.5% and 18.1% of industrial sales across the respective 5-year and 10-year timeframes. As with UCT machine drive, lighting and process again make up a majority of the economic TRC savings potential. Table 8-7 shows the demand savings potential in 2018 and 2023. The five and ten year summer peak demand savings potential is 1,104 MW, which is 25% and 24.4% of the 5-year and 10-year peak forecasts.

Table 8-6: Industrial Sector Economic Potential (TRC) Savings By End Use

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
Machine Drive	3,201,782	51%	3,201,782	51%
Lighting	1,448,206	23%	1,448,206	23%
Process	507,256	8%	507,256	8%
Ventilation	417,190	7%	417,190	7%
Space Cooling	207,775	3%	207,775	3%
Other	140,592	2%	140,592	2%

END USE	2018 ENERGY SAVINGS (MWH)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MWH)	% OF 2023 TOTAL
HVAC Controls	108,073	2%	108,073	2%
Space Heating	81,890	1%	81,890	1%
Envelope	57,453	1%	57,453	1%
Office Equipment	56,283	1%	56,283	1%
Water Heating	43,139	1%	43,139	1%
Refrigeration	29,147	0%	29,147	0%
Cooking	3,607	0%	3,607	0%
Total	**6,302,402**	**100%**	**6,302,402**	**100%**
% of Annual Sales Forecast	*18.5%*		*18.1%*	

Table 8-7: Industrial Sector Economic Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**1,104**	**1,104**
% of Peak	*25.0%*	*24.4%*

8.1.3 Achievable Potential Savings in the Industrial Sector

Achievable potential is an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles. This study estimated achievable potential for three scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. Unlike the economic potential, the industrial achievable potential takes into account the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment. The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

8.1.3.1 UCT vs. TRC

Tables 8-8 through 8-11 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is slightly less than 0.7 million MWh greater, over the next decade, than the achievable TRC scenario.

Table 8-8: Industrial Achievable UCT Potential Electric Energy Savings by End Use

	2018	% OF 2018	2023	% OF 2023
Machine Drive	834,143	42%	1,606,885	42%
Lighting and Controls	690,425	35%	1,330,027	35%
Process Cool/Heat	133,546	7%	257,261	7%
Ventilation	123,558	6%	238,021	6%
Space Cooling	67,816	3%	130,640	3%

	2018	% OF 2018	2023	% OF 2023
HVAC Controls	43,768	2%	84,314	2%
Space Heating	29,385	1%	56,607	1%
Other	19,424	1%	37,418	1%
Office Equipment	18,617	1%	35,864	1%
Water Heating	17,672	1%	34,043	1%
Refrigeration	10,958	1%	21,110	1%
Envelope	7,489	0%	14,426	0%
Cooking	1,455	0%	2,802	0%
Total	1,998,256	100%	3,849,419	100%
% of Annual Sales Forecast	*5.9%*		*11.1%*	

Table 8-9: Industrial Achievable UCT Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**417**	**829**
% of Peak	*9.5%*	*18.3%*

Table 8-10: Industrial Achievable TRC Potential Electric Energy Savings by End Use

	2018	% OF 2018	2023	% OF 2023
Machine Drive	839,967	42%	1,610,081	42%
Lighting	454,043	35%	870,327	35%
Process	134,309	7%	257,449	7%
Ventilation	124,164	6%	238,002	6%
Space Cooling	64,161	3%	122,987	3%
HVAC Controls	43,986	2%	84,314	2%
Space Heating	28,707	1%	55,027	1%
Other	19,521	1%	37,418	1%
Office Equipment	17,823	1%	34,163	1%
Water Heating	17,161	1%	32,895	1%
Refrigeration	10,609	1%	20,336	1%
Envelope	7,484	0%	14,346	0%
Cooking	1,260	0%	2,415	0%
Total	1,763,195	100%	3,379,759	100%
% of Annual Sales Forecast	*5.2%*		*9.7%*	

Table 8-11: Industrial Achievable TRC Potential Demand Savings

	SUMMER PEAK DEMAND	
	2018	**2023**
Summary	**MW**	**MW**
Total	**305**	**562**
% of Peak	*6.9%*	*12.4%*

8.1.3.2 Achievable UCT vs. Constrained UCT

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the Constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of Michigan annual utility revenues. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential.

Tables 8-12 and 8-13 show the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are approximately 484 thousand MWh and 1,044 thousand MWh. This equates to 1.4% and 3.0% of sector sales in 2018 and 2023. The five and ten year summer demand savings estimates in the Constrained UCT scenario are 101 MW and 228 MW, respectively, which is 2.3% and 5.1% of the peak forecast.

Table 8-12: Industrial Constrained Achievable Energy Savings by End Use

End Use	2018 Energy (MWh)	% of 2018 Savings	2023 Energy (MWh)	% of 2023 Savings
Machine Drive	197,418	41%	443,226	42%
Lighting	118,171	33%	262,712	34%
Process Cool/Heat	31,180	6%	69,264	7%
Ventilation	31,694	7%	65,009	6%
Space Cooling	19,585	4%	33,218	3%
HVAC Controls	13,759	3%	20,653	2%
Space Heating	9,122	2%	14,238	1%
Other	4,535	1%	10,074	1%
Office Equipment	4,623	1%	10,831	1%
Water Heating	5,465	1%	8,572	1%
Refrigeration	3,029	1%	5,606	1%
Envelope	1,754	0%	3,882	0%
Cooking	340	0%	754	0%
Total	484,455	100%	1,043,685	100%
% of Annual Sales Forecast	*1.4%*		*3.0%*	

Table 8-13: Industrial Constrained Achievable Demand Savings

	Summer Peak Demand	
	2018	**2023**
Summary	**MW**	**MW**
Total	**101**	**228**
% of Peak	*2.3%*	*5.1%*

Figure 8-2 shows the estimated 10-year cumulative efficiency savings potential broken out by end use across the entire industrial sector for the Constrained UCT scenario. The Machine Drive end use shows the largest potential for savings at just over 0.44 million MWh, or 42% of total savings, in the Constrained UCT scenario. Lighting is second at just over 0.26 million MWh, or 34% of total savings.

Figure 8-2: Industrial Sector 2023 Constrained UCT Potential Savings by End Use

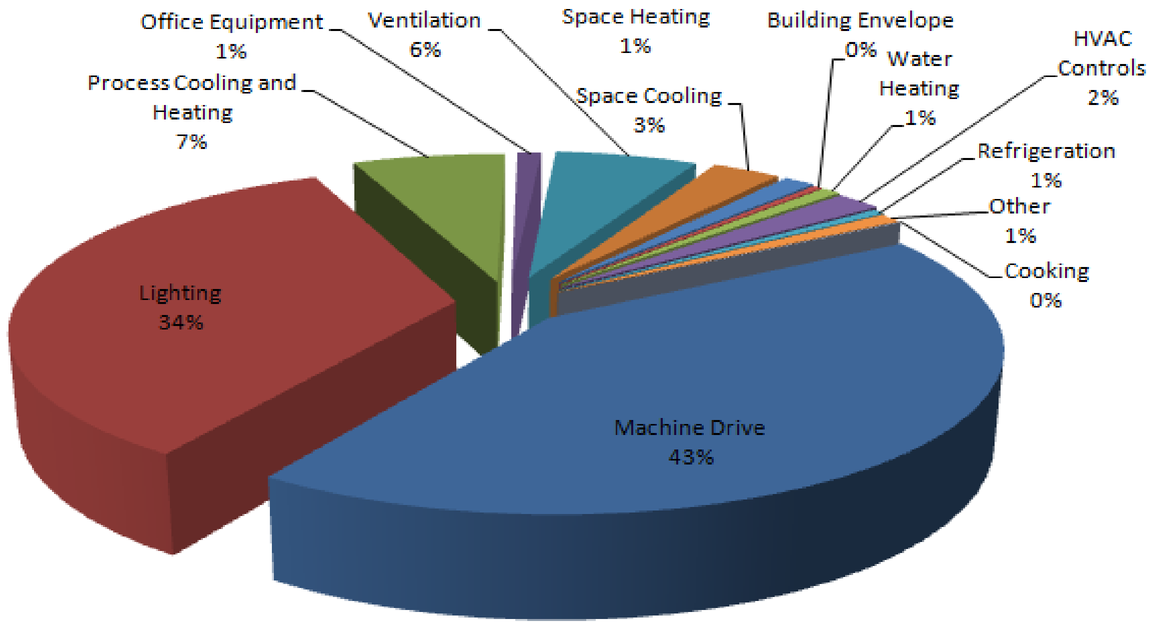
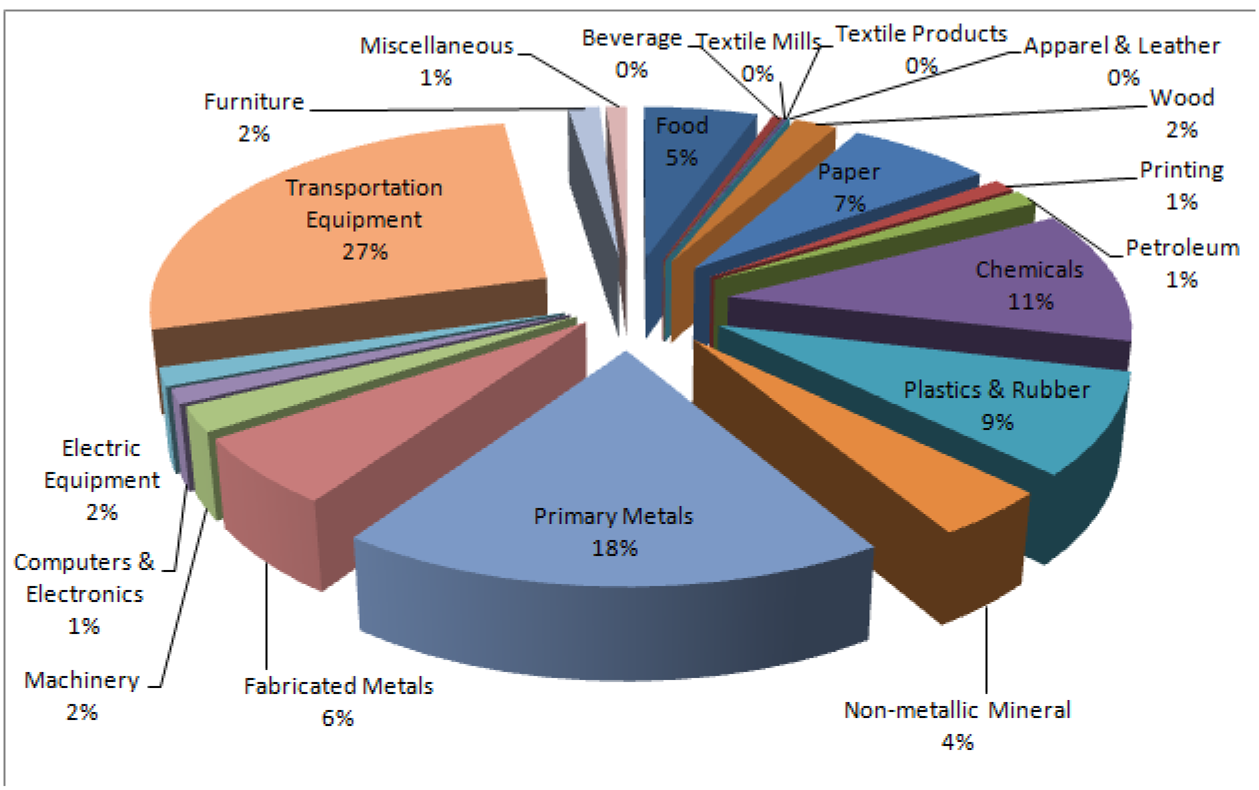


Figure 8-3 shows the breakdown of estimated savings in 2023 by building type for the Constrained UCT scenario. The vast majority of savings come from the transportation equipment, primary metals, chemicals, plastics and rubber, fabricated metals, paper, and food industries, with the other SIC codes accounting for less than 20% of total savings.

Figure 8-3: Industrial Constrained UCT Savings in 2023 by Industry



8.1.4 Annual Achievable Electric Savings Potential

Tables 8-14, Table 8-15 and Table 8-16 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 8-14: Cumulative Annual Industrial Energy Savings in the Achievable UCT Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	160,688	321,377	482,065	642,754	803,442	964,131	1,124,819	1,285,508	1,446,196	1,606,885
Lighting	132,472	266,005	400,068	534,131	667,134	800,137	932,609	1,065,082	1,197,554	1,330,027
Process	25,726	51,452	77,178	102,904	128,631	154,357	180,083	205,809	231,535	257,261
Ventilation	19,843	47,604	79,325	111,046	134,848	158,651	178,493	198,336	218,178	238,021
Space Cooling	8,596	26,128	48,127	70,126	83,190	96,254	104,851	113,447	122,044	130,640
HVAC Controls	4,216	16,863	33,726	50,589	59,020	67,451	71,667	75,883	80,099	84,314
Other	3,742	7,484	11,225	14,967	18,709	22,451	26,193	29,934	33,676	37,418
Office Equipment	3,220	7,173	11,492	15,811	19,397	22,984	26,204	29,424	32,644	35,864
Space Heating	2,968	11,321	22,367	33,413	39,074	44,735	47,703	50,671	53,639	56,607
Water Heating	1,810	6,809	13,401	19,993	23,397	26,802	28,612	30,423	32,233	34,043
Refrigeration	1,557	4,222	7,440	10,659	12,770	14,881	16,438	17,995	19,553	21,110
Building Envelope	1,436	2,885	4,342	5,799	7,242	8,684	10,120	11,555	12,991	14,426
Cooking	978	1,956	2,934	3,912	4,890	5,868	6,847	7,825	8,803	9,781
Total	**366,555**	**769,884**	**1,191,599**	**1,613,315**	**1,998,256**	**2,383,198**	**2,749,754**	**3,116,309**	**3,482,864**	**3,849,419**
% of Annual Sales Forecast	***1.2%***	***2.4%***	***3.6%***	***4.8%***	***5.9%***	***7.0%***	***8.0%***	***9.0%***	***10.1%***	***11.1%***

Table 8-15: Cumulative Annual Industrial Energy Savings in the Achievable TRC Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	161,008	322,016	483,024	644,032	805,041	966,049	1,127,057	1,288,065	1,449,073	1,610,081
Lighting	86,503	174,065	262,158	350,251	437,284	524,317	610,819	697,322	783,824	870,327
Process	25,745	51,490	77,235	102,980	128,725	154,470	180,214	205,959	231,704	257,449
Ventilation	19,841	47,600	79,320	111,039	134,839	158,639	178,480	198,321	218,161	238,002
Space Cooling	7,831	24,597	45,831	67,066	79,364	91,663	99,494	107,325	115,156	122,987
HVAC Controls	4,216	16,863	33,726	50,589	59,020	67,451	71,667	75,883	80,099	84,314
Other	3,742	7,484	11,225	14,967	18,709	22,451	26,193	29,934	33,676	37,418
Office Equipment	3,050	6,833	10,981	15,130	18,547	21,963	25,013	28,063	31,113	34,163
Space Heating	2,810	11,005	21,893	32,781	38,284	43,787	46,597	49,407	52,217	55,027

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Water Heating	1,741	6,579	12,965	19,351	22,641	25,930	27,671	29,413	31,154	32,895
Refrigeration	1,492	4,067	7,183	10,300	12,333	14,367	15,859	17,352	18,844	20,336
Building Envelope	1,428	2,869	4,318	5,767	7,201	8,636	10,063	11,491	12,918	14,346
Cooking	241	483	724	966	1,207	1,449	1,690	1,932	2,173	2,415
Total	**319,647**	**675,952**	**1,050,586**	**1,425,219**	**1,763,195**	**2,101,171**	**2,420,818**	**2,740,465**	**3,060,112**	**3,379,759**
% of Annual Sales Forecast	***1.0%***	***2.1%***	***3.2%***	***4.3%***	***5.2%***	***6.2%***	***7.0%***	***7.9%***	***8.8%***	***9.7%***

Table 8-16: Cumulative Annual Industrial Energy Savings in Constrained UCT Potential Scenario by End Use

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Machine Drive	44,114	80,437	114,965	150,840	197,418	240,941	293,405	343,162	393,226	443,226
Lighting	7,063	13,043	18,676	24,385	31,181	38,077	45,733	53,507	61,361	69,264
Process	884	1,803	2,749	3,707	4,623	5,719	7,004	8,310	9,560	10,831
Ventilation	497	1,659	3,102	4,565	5,465	6,377	6,916	7,463	8,016	8,572
Space Cooling	394	731	1,050	1,373	1,754	2,141	2,568	3,002	3,440	3,882
HVAC Controls	5,442	11,882	18,811	25,466	31,964	38,676	45,629	52,149	58,718	65,009
Other	2,360	6,435	11,253	16,134	19,585	23,088	25,646	28,243	31,148	33,218
Office Equipment	1,157	4,097	7,790	11,532	13,759	16,019	17,274	18,548	19,835	20,653
Space Heating	77	142	203	266	340	415	498	583	668	754
Water Heating	36,367	67,408	96,692	126,428	161,680	197,455	237,007	277,173	317,657	358,358
Refrigeration	428	1,047	1,739	2,450	3,029	3,619	4,116	4,624	5,117	5,606
Building Envelope	815	2,757	5,175	7,627	9,122	10,639	11,523	12,420	13,326	14,238
Cooking	1,027	1,897	2,716	3,547	4,535	5,538	6,652	7,783	8,925	10,074
Total	**100,624**	**193,337**	**284,921**	**378,321**	**484,455**	**588,705**	**703,969**	**816,967**	**930,997**	**1,043,685**
% of Annual Sales Forecast	***0.3%***	***0.6%***	***0.9%***	***1.1%***	***1.4%***	***1.7%***	***2.0%***	***2.3%***	***2.7%***	***3.0%***

8.1.5 Industrial Electric Savings Summary by Measure Group

Table 8-17 below provides an end-use breakdown of the industrial electric savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained UCT potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 8-17 Electric Potential by End-Use and Measure

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Water Heating						
Low Flow Faucet Aerator	27,702	27,702	27,702	21,744	21,744	5,449
Tank Insulation (electric)	9,960	9,960	9,960	7,818	7,818	1,959
ES Dishwasher, Low Temp, Elec Heat	47	47	47	23	23	6
Heat Pump Water Heater	3,213	3,213	3,224	1,671	1,678	450
Efficient Hot Water Pump	1,672	1,672	1,670	1,312	1,311	329
ES Dishwasher, High Temp, Elec Heat, Elec Booster	8	8	8	4	4	1
Hot Water Circulation Pump Time-Clock	40	40	40	32	31	8
ES Dishwasher, High Temp, Gas Heat, Elec Booster	45	45	45	22	22	6
Hot Water (DHW) Pipe Insulation	80	80	79	62	62	16
High Efficiency Electric Water Heater	335	335	335	189	189	51
ES Dishwasher, High Temp, Gas Heat, Gas Booster	26	26	26	11	11	3
Solar Water Heating System	1,241	1,241	0	910	0	228
Drain water Heat Recovery Water Heater	623	623	0	244	0	66
Point of Use Water Heating	25	0	0	0	0	0
ES Dishwasher, Low Temp, Gas Heat	1	0	2	0	1	0
Ventilation						
Electronically-Commutated Permanent Magnet Motors (ECPMs)	21,226	21,226	21,226	8,490	8,490	1,712
Demand-Controlled Ventilation	28,933	28,933	28,896	15,352	15,327	3,096
High Performance Air Filters	139,204	139,204	139,208	69,602	69,604	32,225
Variable Speed Drive Control, 15 HP	47,233	47,233	47,233	37,787	37,787	7,094
Variable Speed Drive Control, 5 HP	35,882	35,882	35,883	28,328	28,329	5,318
Variable Speed Drive Control, 40 HP	7,630	7,630	7,631	363	363	68
Controled Ventilation Optimization	112,610	112,610	112,614	63,985	63,987	12,903
Enthalpy Economizer	210,030	0	0	0	0	0
Improved Duct Sealing	2,428	3,311	3,311	1,401	1,401	278
Destratification Fan	15,542	21,187	21,188	12,712	12,713	2,314
Space Cooling - Chillers						

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Efficient Chilled Water Pump	26,713	36,263	36,265	29,011	29,012	6,895
Chilled Hot Water Reset	43,183	57,280	57,282	45,824	45,826	12,223
Water-Cooled Screw Chiller > 300 ton	9,869	9,869	9,869	3,948	3,948	1,008
Air-Cooled Recip Chiller	12,928	17,229	17,229	6,043	6,043	1,543
Water-Cooled Centrifugal Chiller > 300 ton	7,547	10,057	10,057	3,017	3,017	770
Air-Cooled Screw Chiller	12,609	16,803	16,803	5,893	5,894	1,505
Water-Cooled Screw Chiller 150 - 300 ton	4,763	4,763	4,763	1,429	1,429	365
Water-Cooled Centrifugal Chiller 150 - 300 ton	7,127	9,521	9,521	2,856	2,856	729
Water-Cooled Screw Chiller < 150 ton	11,581	15,471	15,472	6,107	6,107	1,559
Water-Cooled Centrifugal Chiller < 150 ton	9,257	12,366	12,366	4,337	4,337	1,108
High Efficiency Pumps	13,584	18,146	18,147	14,517	14,518	3,451
Space Cooling - Unitary and Split AC						
Water Loop Heat Pump (WLHP) - Cooling	5,985	5,985	0	3,103	0	836
High Efficiency AC - Unitary & Split Systems	11,385	11,385	0	4,554	0	1,226
Ductless (mini split) - Cooling	84,444	0	0	0	0	0
Ground Source Heat Pump - Cooling	82,437	0	0	0	0	0
Lighting						
Lighting Power Density - Exceed Code by 10%	7,800	7,800	7,800	5,200	5,200	1,378
CFL Screw in Specialty	0	0	0	0	0	0
Occupancy Sensors for LED Refrigerator Lighting	10,028	10,028	10,028	5,014	5,014	1,329
CFL Screw-in	15,364	15,364	15,451	11,791	11,878	9,688
LED Exit Sign	10,231	10,231	10,231	3,323	3,323	870
30% More Efficient Design - New Construction	16,430	16,430	16,429	8,492	8,491	2,250
15% More Efficient Design - New Construction	8,171	8,171	8,171	4,223	4,223	1,119
CFL Fixture	2,988	2,988	3,005	1,911	1,925	501
CFL Flood	1,607	1,607	1,616	1,233	1,242	1,014
LED Pin Based Lamp	11,313	11,313	11,377	5,788	5,830	1,516
LED Screw In	12,228	12,228	12,297	6,256	6,302	1,639
Daylight Dimming - New Construction	9,072	9,072	9,071	7,258	7,257	1,790
HID Fixture Upgrade - Pulse Start Metal Halide	166	166	172	0	0	0
Central Lighting Control	226,105	226,105	226,087	150,737	150,724	39,944
Daylight Dimming	4,183	4,183	4,183	3,346	3,346	825
High Intensity Fluorescent Fixture	205	205	207	0	0	0

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
(replacing HID)						
Stairwell Bi-Level Control	69,913	69,913	69,700	55,789	55,577	16,471
LED Wallpack	487,901	487,901	487,898	260,214	260,212	68,151
Remote Mounted Occupancy Sensor	29,309	29,309	29,309	23,139	23,139	6,132
Switching Controls for Multilevel Lighting (Non-HID)	105,482	105,482	105,482	70,144	70,143	18,588
LED Replacing Halogen Incandescent	1,015	1,015	1,021	779	785	250
Controls for H.I.F.	6,138	6,138	6,138	4,910	4,910	1,301
New Fluorescent Fixtures T5/HP T8 reduced wattage (replacing T8)	12,789	12,789	12,906	0	0	0
Induction Fluorescent	4,848	4,848	4,847	3,103	3,102	905
LED Downlight	882	882	887	655	660	172
Fluorescent Fixture with Reflectors	7,552	7,552	7,620	0	0	0
Lamp & Ballast Retrofit (HPT8 Replacing T12)	30,791	30,791	30,730	19,476	19,426	5,101
Lamp & Ballast Retrofit (Low Wattage HPT8 Replacing Standard T8)	6,491	6,491	5,498	0	0	0
CFL Exterior Lighting	323,801	323,801	324,817	204,021	204,661	53,433
Parking Garage LED	815	815	840	0	0	0
LED Lighting in Refrigeration	5,507	5,507	5,538	2,642	2,661	692
LED Outdoor Area Fixture (Parking Light or Street Light)	18,876	18,876	18,853	10,311	10,294	2,701
T5 HP replacing T12	31,238	31,238	0	19,759	0	5,175
Switch Mounted Occupancy Sensor	21,601	21,601	0	17,053	0	4,519
Illuminated Signs to LED	20,077	20,077	0	16,061	0	4,207
42W 8 lamp Hi Bay CFL	10	10	0	0	0	0
Light Tube	706,218	706,218	0	402,534	0	105,425
Lamp & Ballast Retrofit (HPT8 Replacing Standard T8)	1,930	1,930	0	0	0	0
LED Exterior Flood and Spotlight	127,277	0	0	0	0	0
New Fluorescent Fixtures T5/HP T8 (replacing T12)	8,240	9,613	0	4,864	0	1,274
Controls for HID (Hi/Lo)	37,501	0	0	0	0	0
Computers & Office Equipment						
Energy Star office equipment including computers, monitors, copiers, multi-function machines.	44,835	44,835	44,771	26,901	26,837	8,160
PC Network Energy Management Controls replacing no central control	11,512	11,512	11,512	7,326	7,326	2,406
Energy Star Compliant Single Door Refrigerator	2,924	2,924	0	1,638	0	265
EZ Save Monitor Power Management Software	5,204	0	0	0	0	0

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Energy Efficient "Smart" Power Strip for PC/Monitor/Printer	25,556	0	0	0	0	0
Energy Star UPS	952	0	0	0	0	0
Building Envelope						
Wall Insulation R-7.5 to R13	425	425	425	142	142	36
Integrated Building Design	56,459	56,459	56,217	14,285	14,204	3,846
Below Grade Insulation	3	3	4	0	0	0
Ceiling Insulation R-11 to R-42	816	816	807	0	0	0
Energy Efficient Windows	39,548	0	0	0	0	0
Roof Insulation R-11 to R-24	510	510	0	0	0	0
Cool Roofing	8,418	0	0	0	0	0
HVAC Controls						
EMS Optimization	6,041	6,041	6,041	4,820	4,820	1,181
EMS install	56,059	56,059	56,059	44,734	44,734	10,958
Programmable Thermostats	45,973	45,973	45,973	34,760	34,760	8,514
Cooking						
HE Steamer	1,701	1,701	1,701	1,134	1,134	305
HE Holding Cabinet	1,449	1,449	1,454	948	952	255
HE Combination Oven	1,080	1,080	0	720	0	194
HE Griddle	318	0	0	0	0	0
HE Convection Ovens	336	0	0	0	0	0
Induction Cooktops	433	442	452	321	329	0
HE Fryer	147	0		0		0
Refrigeration						
H.E. Evaporative Fan Motors	7,993	7,993	7,925	6,395	6,340	1,277
Floating Head Pressure Control	372	372	441	298	353	59
ECM case fan motors	6,245	6,245	6,245	3,122	3,122	670
ENERGY STAR Commercial Glass Door Freezers	4,154	4,154	4,141	2,762	2,752	592
Refrigerated Case Covers	380	380	380	304	304	133
Door Heater Controls	2,855	2,855	2,870	2,114	2,128	422
Zero-Energy Doors	954	954	957	756	758	162
ENERGY STAR Commercial Solid Door Freezers	210	210	210	140	140	30
Refrigerant charging correction	3,144	3,144	3,144	2,358	2,358	1,587
Vending Miser for Soft Drink Vending Machines	1,346	1,346	1,346	1,077	1,077	215
Discus and Scroll Compressors	681	681	678	382	380	82
Reach-in Refrigerated display case door retrofit	473	473	473	355	355	71

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Evaporator Fan Motor Controls on S-P motors	337	337	337	270	270	99
ENERGY STAR Commercial Glass Door Refrigerators	231	231	0	154	0	33
Evaporator Fan Motor Controls on PSC motors	328	328	0	263	0	97
Refrigeration Economizer	301	301	0	0	0	0
ENERGY STAR Commercial Solid Door Refrigerators	542	542	0	361	0	77
Commercial Ice-makers	137	0	0	0	0	0
Efficient low-temp compressor	94	0	0	0	0	0
Evaporator Fan Motor Controls on ECM motors	231	0	0	0	0	0
Space Heating						
VFD Pump	32,279	32,279	32,279	19,368	19,368	4,854
High Efficiency Pumps	5,612	5,282	5,282	1,174	1,174	316
Water Loop Heat Pump (WLHP) - Heating	3,237	3,047	0	1,580	0	425
High Efficiency Heat Pump	10,596	0	0	0	0	0
Ground Source Heat Pump - Heating	50,806	0	0	0	0	0
Ductless (mini split) - Heating	56,853	0	0	0	0	0
Other						
NEMA Premium Transformer, three-phase	86,871	86,871	86,871	23,166	23,166	6,237
NEMA Premium Transformer, single-phase	53,720	53,720	53,720	14,252	14,252	3,837
Process Heating						
Electric Supply System Improvements	96,733	96,733	96,530	48,566	48,430	13,076
Sensors & Controls	94,383	94,383	94,190	47,386	47,256	12,758
Energy Information System	30,696	30,696	30,635	15,411	15,370	4,149
Process Cooling and Refrigeration						
Improved Refrigeration	123,169	123,169	123,498	63,017	63,236	16,966
Electric Supply System Improvements	70,724	70,724	70,904	36,184	36,306	9,742
Sensors & Controls	68,899	68,899	69,070	35,251	35,367	9,491
Energy Information System	22,374	22,374	22,428	11,447	11,484	3,082
Machine Drive						
Compressed Air - Advanced Compressor Controls	59,930	59,930	60,021	28,855	28,916	4,568
Advanced Lubricants	49,571	49,571	49,647	35,801	35,877	32,700
Compressed Air System Management	288,930	288,930	289,368	208,672	209,111	190,595
Pump System Efficiency Improvements	346,217	346,217	346,731	166,697	167,043	26,390
Motor System Optimization (Including ASD)	1,535,070	1,535,070	1,537,293	739,108	740,612	117,009

End Use	Technical Potential (MWh)	Economic Potential -UCT- (MWh)	Economic Potential -TRC- (MWh)	Achievable Potential -UCT- (MWh)	Achievable Potential -TRC- (MWh)	Constrained Achievable -UCT- (MWh)
Electric Supply System Improvements	269,817	269,817	270,157	129,912	130,152	20,567
Sensors & Controls	263,989	263,989	264,313	127,106	127,336	20,122
Fan System Improvements	74,903	74,903	74,992	36,064	36,129	5,709
Advanced Efficient Motors	157,424	157,424	157,610	45,478	45,558	7,200
Industrial Motor Management	67,538	67,538	67,617	48,778	48,863	11,968
Energy Information System	83,937	83,937	84,033	40,414	40,484	6,398
Total	**7,640,370**	**7,116,215**	**6,302,402**	**3,849,419**	**3,379,759**	**1,043,685**
% of Annual Sales Forecast	**22.0%**	**20.5%**	**18.1%**	**11.1%**	**9.7%**	**3.0%**
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the SCT Test.						

8.2 INDUSTRIAL NATURAL GAS POTENTIAL

The GDS Associates natural gas consumption forecasts for the residential, commercial and industrial segments of the Michigan economy indicates that natural gas use demand will decrease by about 10% from 656.2 trillion BTU in 2013 to 587.2 trillion BTU in 2023.[37] Over that same period industrial natural gas use is expected to decline by about 4% from 2012 levels.

8.2.1 Natural Gas Energy Efficiency Measures Examined

For the industrial sector, there were 52 unique natural gas energy efficiency measures included in the potential natural gas savings analysis. Table 8-18 provides a brief description of the types of natural gas energy efficiency measures included for each end use in the industrial sector. The list of measures was developed based on a review of the Michigan Energy Measures Database (MEMD), and measures found in other Technical Reference Manuals (TRMs) and industrial potential studies. For each measure, the analysis considered incremental costs, energy savings, and useful measure life.

Table 8-18: Measures and Programs Included in the Industrial Sector Analysis

END USE TYPE	END USE DESCRIPTION	MEASURES/PROGRAMS INCLUDED
Building Envelope	Building Insulation & Air Sealing	• Wall Insulation R-7.5 to R13 • Integrated Building Design • Below Grade Insulation • Ceiling Insulation R-11 to R-42 • Energy Efficient Windows • Roof Insulation R-11 to R-24
Conventional Boiler Use	Boiler Improvements	• Insulate Steam Lines / Condensate Tank • Repair Malfunctioning Steam Traps • High Efficiency Hot Water Boiler (>300,000 Btu/h) • Condensing Boiler (>300,000 Btu/h)

[37] GDS applied a forecast trends to actual deliveries by customer classes as reported by the U.S. Energy Information Administration (EIA). The annual sales forecast trends are based the EAI's Long term Reference Case forecast of natural gas consumption for the East North Central Region (Illinois, Indiana, Michigan, Ohio, and Wisconsin) as reported in the EIA 2013 Annual Energy Outlook.

END USE TYPE	END USE DESCRIPTION	MEASURES/PROGRAMS INCLUDED
		(EF>90%) • Boiler Pipe Insulation • High Efficiency Steam Boiler (>300,000 Btu/h) • Boiler Reset Controls • Boiler Blowdown Heat Exchanger (Steam) • High Efficiency Hot Water Boiler (<=300,000 Btu/h) • Boiler Tune-Up • High Efficiency Steam Boiler (<=300,000 Btu/h) • Condensing Boiler (<=300,000 Btu/h) • Boiler O2 Trim Controls • Electronic Parallel Positioning Controls (linkage less)
Facility HVAC	HVAC improvements	• Stack Heat Exchanger (Condensing Economizer) • Stack Heat Exchanger (Standard Economizer) • High Efficiency Furnace (<=300,000 Btu/h) • Infrared Heater (low intensity - two stage) • Direct Fired Make-up Air System • Gas Unit Heater - Condensing • Heat Recovery: Air to Air • Insulate and Seal Ducts (New Aerosl Duct Sealing)
HVAC Controls	HVAC Controls Improvement	• EMS Optimization • EMS install • Programmable Thermostats
Process Heating	Process Heating Improvements	• Regenerative Thermal Oxidizer vs. STO • Boiler Pipe Insulation • High Efficiency Hot Water Boiler (>300,000 Btu/h) • Refrigeration Heat Recovery • Direct Contact Water Heater • Condensing Boiler (>300,000 Btu/h) (EF>90%) • High Efficiency Steam Boiler (>300,000 Btu/h) • Boiler Reset Controls • Boiler Tune-Up

END USE TYPE	END USE DESCRIPTION	MEASURES/PROGRAMS INCLUDED
		• Regenerative Thermal Oxidizer vs. CTO • Direct Fired Make-up Air System • Improved Sensors & Process Controls • Boiler O2 Trim Controls • Electronic Parallel Positioning Controls (linkage less) • Waste-Heat Recovery
Ventilation	Ventilation & Fans	• Demand-Controlled Ventilation • Controlled Ventilation Optimization • Improved Duct Sealing • Destratification Fan

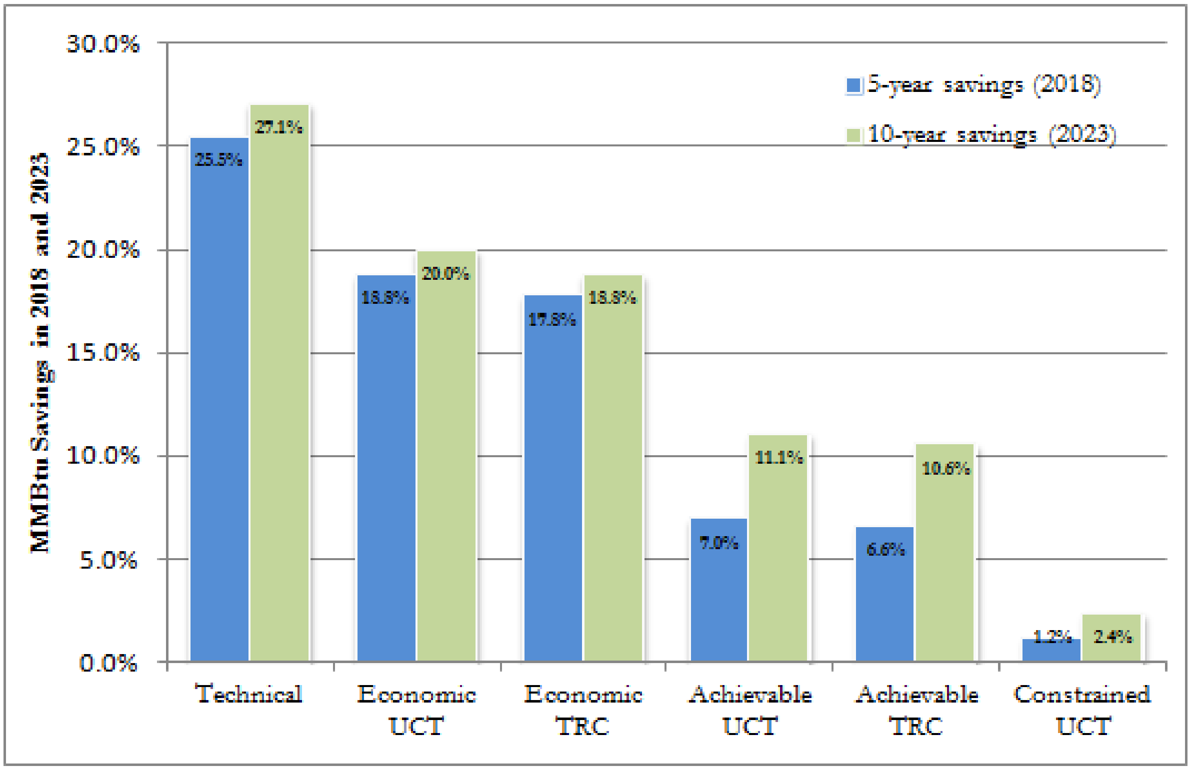
8.2.2 Technical and Economic Potential Natural Gas Savings

This section presents estimates for natural gas technical, economic, and achievable potential for the industrial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative savings (MMBtu) and percentage of sales. Data is provided for a 5 and 10-year horizon for Michigan

SUMMARY OF FINDINGS

Figure 8-4 illustrates the estimated savings potential for each of all the scenarios included in this study.

Figure 8-4: Summary of Industrial Natural Gas Energy Efficiency Potential as a % Sales Forecasts



The potential estimates are expressed as cumulative 5-year and 10-year savings, as percentages of the respective 2018 and 2023 industrial sector sales. The technical potential is 25.5% in 2018 and 27.1% in 2023. The 5-year and 10-year economic potential is 18.8% and 20.0% based on the Utility Cost Test (UCT) screen, assuming an incentive level equal to 50% of the measure cost. Based on a measure-level screen using the TRC Test, the economic potential is 17.8% in 2018 and 18.8% in 2023. The slight drop from technical potential to economic potential indicates that most measures are cost-effective.

The 5-year and 10-year achievable potential savings are: 7.0% and 11.1% for the Achievable UCT scenario; 6.6% and 10.6% for the Achievable TRC scenario; and 1.2% and 2.4% for the Constrained Achievable scenario. The Achievable UCT scenario assumes 50% incentives and includes measures that passed the UCT Test. The Achievable TRC scenario also assumes 50% incentives but includes only measures that passed the cost-effectiveness screen based on the TRC Test. Last, the Constrained Achievable scenario is a subset of Achievable UCT scenario, assuming a spending cap on non-residential DSM approximately equal to 2% of future annual industrial and industrial revenue. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will allocated at the sector level based on where the savings opportunities are found.

TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 7-19 shows that it is technically feasible to save nearly 41.4 million MMBtu during the 10 year period from 2013 to 2023 across Michigan, representing just over 25.5% and 27.1% of respective 5-year and 10-year industrial sales. Process heating represents the majority of the potential at 54% of 10-

yr savings, while ventilation and HVAC controls represent the smallest share each with less than 3 percent of 10-yr savings.

Table 8-19: Industrial Sector Technical Potential MMBtu Savings By End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	22,355,463	54%	22,355,463	54%
Envelope	7,613,098	18%	7,613,098	18%
Facility HVAC	6,784,448	16%	6,784,448	16%
Conventional Boiler Use	3,223,646	8%	3,223,646	8%
Ventilation	966,299	2%	966,299	2%
HVAC Controls	493,779	1%	493,779	1%
Total	41,436,733	100%	41,436,733	100%
Percent of Annual Sales Forecast	25.5%		27.1%	

ECONOMIC POTENTIAL

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective. This analysis includes two estimates of economic potential. One cost-effectiveness screen is based on the UCT and a second economic potential scenario was screened using the TRC Test. In both scenarios, the utility incentive was assumed to be equal to 50% of the measure incremental cost. The UCT was used for this study because it is mandated in Michigan to be the primary cost-effectiveness test used when considering energy efficiency programs. Because the TRC includes participant costs, it goes beyond utility resource acquisition and looks at the measure/program from a more broad perspective. 89% of all measures that were included in the electric potential analysis passed the UCT and 89% of all measures passed the TRC Test.

Table 8-20 indicates that the economic potential based on the UCT screen is just over 30 million MMBTu during the 10 year period from 2014 to 2023. This represents 18.8% and 20.0% of industrial sales across the respective 5-year and 10-year timeframes. Process heating again makes up a majority of the savings.

Table 8-20: Industrial Sector Economic Natural Gas UCT Savings By End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	20,963,768	68%	20,963,768	68%
Facility HVAC	5,556,906	18%	5,556,906	18%
Conventional Boiler Use	3,067,574	10%	3,067,574	10%
Ventilation	260,068	1%	260,068	1%
HVAC Controls	493,779	2%	493,779	2%
Envelope	338,643	1%	338,643	1%
Total	30,680,739	100%	30,680,739	100%
Percent of Annual Sales Forecast	18.8%		20.0%	

Table 8-21 shows that the economic potential based on the TRC screen is slightly more than 28 million MMBtu during the 10 year period from 2014 to 2023. This represents 17.8% and 18.8% of industrial sales across the respective 5-year and 10-year timeframes. As with UCT process heating measures continue to makes up a majority of the savings potential.

Table 8-21: Industrial Sector Economic Natural Gas TRC Savings By End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	19,104,253	66%	19,104,253	66%
Facility HVAC	5,556,906	19%	5,556,906	19%
Conventional Boiler Use	3,067,574	11%	3,067,574	11%
Ventilation	1,030,853	4%	1,030,853	4%
HVAC Controls	162,747	1%	162,747	2%
Total	28,922,334	100%	28,922,334	100%
Percent of Annual Sales Forecast	17.8%		18.8%	

8.2.3 Achievable Potential Savings in the Industrial Sector

Achievable potential is an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles. This study estimated achievable potential for three scenarios. The Achievable UCT Scenario determines the achievable potential of all measures that passed the UCT economic screening assuming incentives equal to 50% of the measure cost. Unlike the economic potential, the industrial achievable potential takes into account the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment. The second scenario, Achievable TRC, also assumes incentives set at 50% of the measure incremental cost, but only includes measures that passed the TRC Test economic screening. The third scenario, Constrained UCT, assumes a spending cap equal to 2% of utility revenues, thereby limiting utilities from reaching the ultimate potential estimated in the Achievable UCT scenario.

8.2.3.1 UCT vs. TRC

Tables 8-22 and 8-23 show the estimated savings for the Achievable UCT and Achievable TRC scenarios over 5 and 10 year time horizons. As noted above, both scenarios assume an incentive level approximately equal to 50% of the incremental measure cost and include an estimate 10-year market adoption rates based on incentive levels and equipment replacement cycles. However, because more measures pass the UCT relative to the TRC Test, the Achievable UCT scenario is able to include additional measures that would result in greater savings potential over the next five and ten years. Overall the Achievable UCT scenario results in an achievable potential that is slightly less than 7 million MMBtu greater, over the next decade, than the achievable TRC scenario.

Table 8-22: Industrial Achievable UCT Natural Gas Potential Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	8,500,300	75%	12,731,258	75%
Facility HVAC	1,697,233	15%	2,542,017	15%
Conventional Boiler Use	1,005,389	9%	1,505,813	9%
Ventilation	85,743	1%	128,420	1%
HVAC Controls	76,492	1%	114,565	1%

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Envelope	0	0%	0	0%
Total	11,365,156	100%	17,022,073	100%
Percent of Annual Sales Forecast	7.0%		11.1%	

Table 8-23 Industrial Achievable TRC Natural Gas Potential Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	7,881,628	74%	11,508,595	70%
Facility HVAC	1,500,359	14%	2,542,017	16%
Conventional Boiler Use	972,710	9%	1,505,813	9%
Ventilation	279,828	3%	538,833	3%
HVAC Controls	86,137	1%	123,053	1%
Envelope	0	0%	0	0%
Total	10,720,661	100%	16,218,312	100%
Percent of Annual Sales Forecast	6.6%		10.6%	

8.2.3.2 Achievable UCT vs. Constrained UCT

Although the Achievable UCT assumes incentives are set and capped at 50% of the incremental measure cost, and that measures are typically replaced at the end of their useful life, the Achievable UCT scenario also assumes no DSM spending cap to reach all potential participants. In the Constrained UCT scenario, the analysis assumes a spending cap roughly equal to 2% of Michigan utility revenue. The percent of the non-residential spending cap allocated to the industrial sector is based on the percentage of total non-residential UCT savings that the industrial sector represents. This presumes that the total non-residential spending cap will be allocated at the sector level based on where the savings opportunities are found. To model the impact of a spending cap the market penetration of all cost effective measures was reduced by the ratio of capped spending to uncapped spending that would be required to achieve the Achievable UCT scenario savings potential.

Table 8-24 shows the estimated savings for the Constrained UCT scenario over 5 and 10 year time horizons. The 5-year and 10-year Constrained UCT potential savings estimates are approximately 1,906 thousand MMBtu and 3,685 thousand MMBtu. This equates to 1.2% and 2.4% of sector sales in 2018 and 2023.

Table 8-24: Industrial Constrained UCT Natural Gas Achievable Energy Savings by End Use

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Process Heating	1,441,097	76%	2,725,782	74%
Facility HVAC	271,412	14%	571,601	16%
Conventional Boiler Use	167,054	9%	336,487	9%
Ventilation	13,839	1%	28,823	1%
HVAC Controls	13,061	1%	22,528	1%

END USE	2018 ENERGY SAVINGS (MMBTU)	% OF 2018 TOTAL	2023 ENERGY SAVINGS (MMBTU)	% OF 2023 TOTAL
Envelope	0	0%	0	0%
Total	1,906,463	100%	3,685,220	100%
Percent of Annual Sales Forecast	1.2%		2.4%	

Figure 8-5 shows the estimated 10-year cumulative natural efficiency savings potential broken out by end use across the entire industrial sector. The Process Heating end use shows the largest potential for savings by a wide margin at just under 2.7 million MMBtu, or 74% of total savings, in the Constrained UCT Achievable scenario.

Figure 8-5: Industrial Sector 2023 Constrained UCT Achievable Potential Savings by End Use

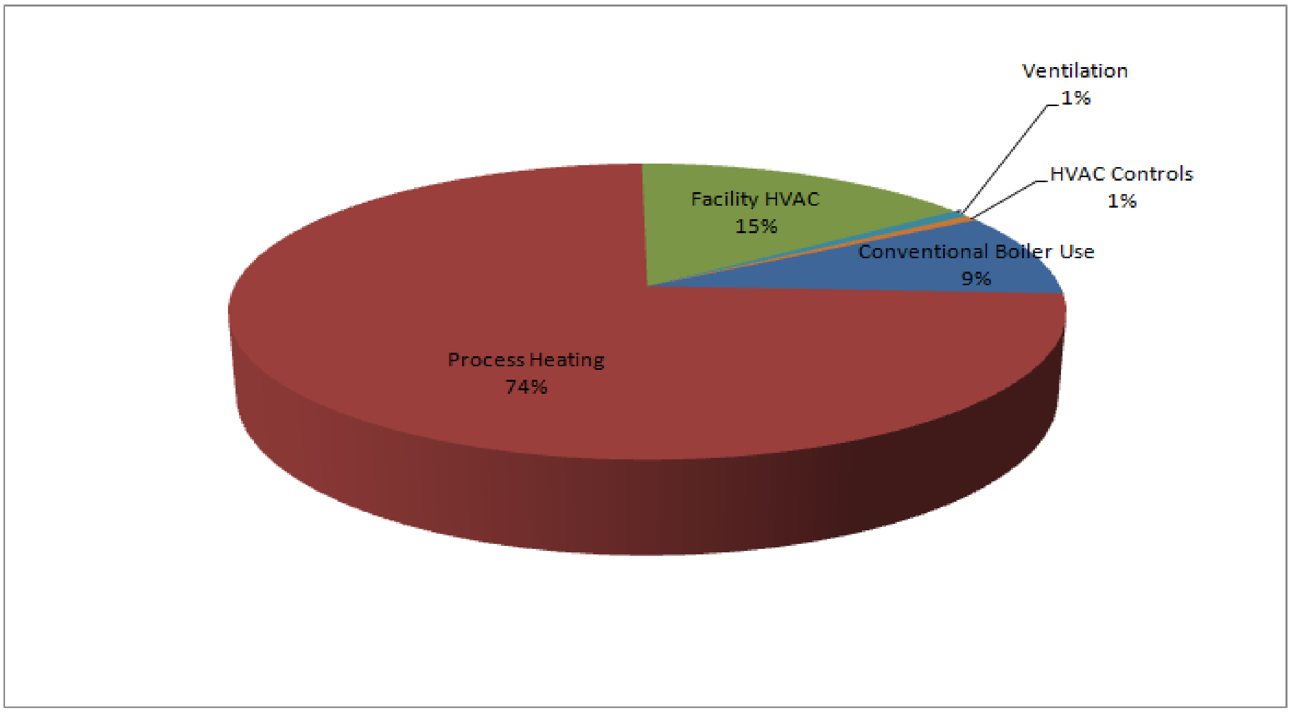
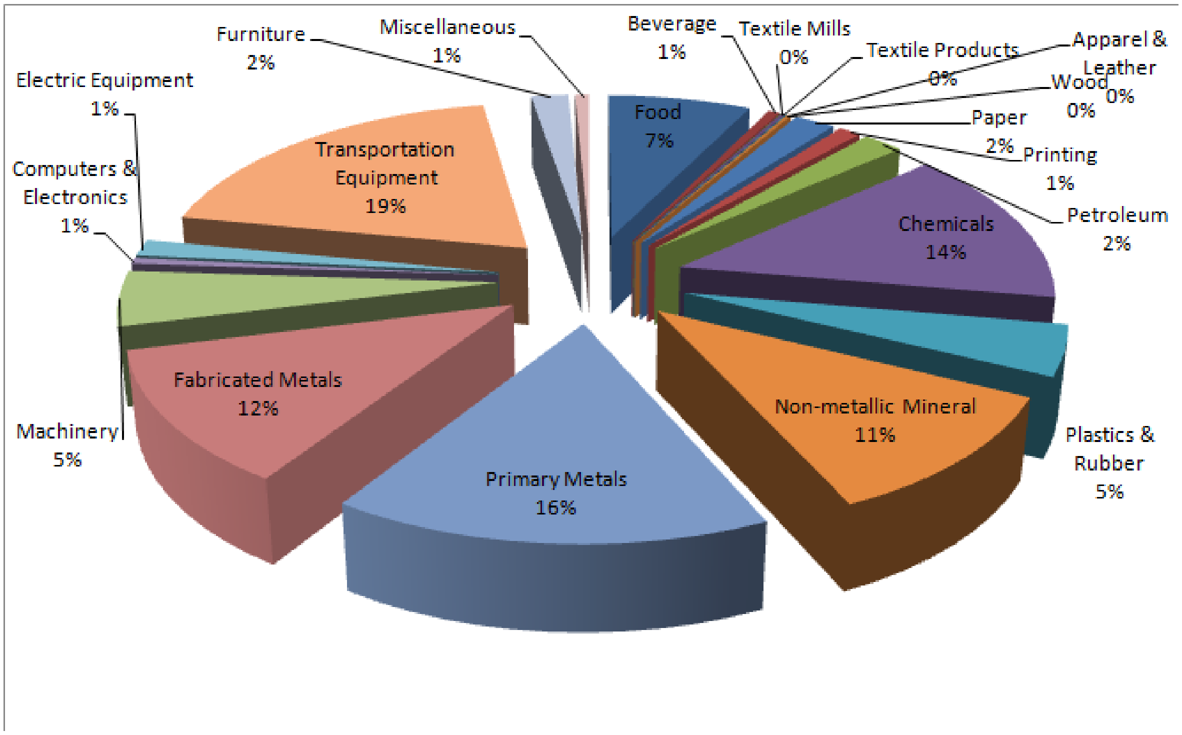


Figure 8-6 shows the breakdown of estimated natural gas savings in 2023 by industry type for the Constrained UCT Achievable scenario. The vast majority of savings come from the transportation equipment, primary metals, chemicals, fabricated metals, non-metallic minerals, and food industries, with all other SIC codes accounting for less than 25% of savings.

Figure 8-6: Industrial Constrained UCT Achievable Potential Savings in 2023 by Industry



Tables 8-25, Table 8-26 and Table 8-27 show cumulative energy savings for all achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 8-25: Cumulative Annual Industrial Natural Gas Savings in the Achievable UCT Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Conventional Boiler Use	95,631	301,163	561,645	822,128	972,710	1,123,291	1,218,922	1,314,552	1,410,183	1,505,813
Process Heating	680,726	2,546,252	5,004,178	7,462,104	8,735,229	10,008,355	10,689,081	11,369,806	12,050,532	12,731,258
Facility HVAC	196,864	508,403	877,280	1,246,158	1,500,359	1,754,561	1,951,425	2,148,289	2,345,153	2,542,017
Building Envelope	0	0	0	0	0	0	0	0	0	0
Ventilation	9,729	25,684	44,752	63,821	76,663	89,505	99,234	108,963	118,691	128,420
HVAC Controls	5,728	22,913	45,826	68,739	80,195	91,652	97,380	103,108	108,836	114,565
Total	**988,677**	**3,404,415**	**6,533,682**	**9,662,949**	**11,365,156**	**13,067,364**	**14,056,041**	**15,044,718**	**16,033,396**	**17,022,073**
% of Annual Sales Forecast	***0.6%***	***2.0%***	***3.9%***	***5.9%***	***7.0%***	***8.2%***	***8.9%***	***9.6%***	***10.3%***	***11.1%***

Table 8-26: Cumulative Annual Industrial Natural Gas Savings in the Achievable TRC Potential Scenario, by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Conventional Boiler Use	301,163	561,645	822,128	972,710	1,123,291	1,218,922	1,314,552	1,410,183	1,505,813	301,163
Process Heating	2,301,719	4,516,244	6,730,768	7,881,628	9,032,487	9,651,514	10,270,541	10,889,568	11,508,595	2,301,719
Facility HVAC	508,403	877,280	1,246,158	1,500,359	1,754,561	1,951,425	2,148,289	2,345,153	2,542,017	508,403
Building Envelope	0	0	0	0	0	0	0	0	132,501	0
Ventilation	107,767	166,856	225,944	279,828	333,711	384,992	436,272	487,553	538,833	107,767
HVAC Controls	24,611	49,221	73,832	86,137	98,442	104,595	110,747	116,900	123,053	24,611
Total	**968,955**	**3,243,662**	**6,171,246**	**9,098,830**	**10,720,661**	**12,342,492**	**13,311,447**	**14,280,402**	**15,249,357**	**16,218,312**
% of Annual Sales Forecast	***0.6%***	***1.9%***	***3.6%***	***5.5%***	***6.5%***	***7.7%***	***8.4%***	***9.1%***	***9.8%***	***10.6%***

Table 8-27: Cumulative Annual Industrial Natural Gas Savings in Constrained Achievable Potential Scenario by End Use for Michigan

END USE	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Conventional Boiler Use	36,786	68,847	98,938	130,262	167,054	199,753	234,363	269,614	301,247	336,487
Process Heating	261,850	552,854	845,423	1,144,303	1,441,097	1,718,659	1,969,834	2,224,088	2,468,536	2,725,782
Facility HVAC	75,726	124,323	168,978	214,119	271,412	326,398	387,596	445,265	504,078	571,601
Building Envelope	0	0	0	0	0	0	0	0	0	0
Ventilation	3,765	6,266	8,585	10,929	13,839	16,631	19,674	22,541	25,465	28,823
HVAC Controls	2,206	4,890	7,668	10,475	13,061	15,542	17,325	19,005	20,719	22,528
Total	**380,334**	**757,180**	**1,129,592**	**1,510,089**	**1,906,463**	**2,276,983**	**2,628,793**	**2,980,514**	**3,320,045**	**3,685,220**
% of Annual Sales Forecast	***0.2%***	***0.4%***	***0.7%***	***0.9%***	***1.2%***	***1.4%***	***1.7%***	***1.9%***	***2.1%***	***2.4%***

8.2.4 Industrial Savings Summary

Table 8-28 provides an end-use breakdown of the industrial natural gas savings potential estimates for technical and economic potential, and each of the three achievable potential scenarios. The table indicates how the savings potential decreases systematically from the technical potential scenario to the Constrained Achievable potential scenario as additional limiting factors such as cost-effectiveness requirements and anticipated market adoption at given funding levels are introduced.

Table 8-28: Natural Gas Potential by End-Use and Measure

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Achievable Potential -TRC- (MMBtu)	Constrained Achievable -UCT- (MMBtu)
Conventional Boiler Use						
Insulate Steam Lines / Condensate Tank	83,878	83,878	83,878	55,919	55,919	8,659
Repair Malfunctioning Steam Traps	417,497	417,497	417,497	278,331	278,331	43,100
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	539,964	539,964	539,964	143,990	143,990	27,863
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	32,637	32,637	32,637	12,088	12,088	2,339
Boiler Pipe Insulation	210,192	210,192	210,192	140,128	140,128	21,699
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	251,634	251,634	251,634	67,102	67,102	12,985
Boiler Reset Controls	511,625	511,625	511,625	341,083	341,083	52,817
Boiler Blowdown Heat Exchanger (Steam)	261,240	261,240	261,240	174,160	174,160	55,617
High Efficiency Hot Water Boiler (<=300,000 Btu/h) (AFUE = 85%-90%)	194,079	194,079	194,079	64,693	64,693	12,518
Boiler Tune-Up	164,090	164,090	164,090	109,393	109,393	75,878
High Efficiency Steam Boiler (<=300,000 Btu/h) (AFUE >=82%)	284,426	284,426	284,426	75,847	75,847	14,677
Condensing Boiler (<=300,000 Btu/h) (AFUE>90%)	116,314	116,314	116,314	43,079	43,079	8,336
Boiler O2 Trim Controls	78,233	0	0	0	0	0
Electronic Parallel Positioning Controls (linkage less)	77,839	0	0	0	0	0
Process Heating						
Regenerative Thermal Oxidizer vs. STO	815,809	815,809	815,809	543,873	543,873	95,287
Boiler Pipe Insulation	210,192	848,957	848,957	565,971	565,971	99,158
High Efficiency Hot Water Boiler (>300,000 Btu/h) (Th. Eff. =85%-90%)	539,964	2,073,437	2,030,241	552,917	541,398	121,053
Refrigeration Heat Recovery	7,164,249	7,164,249	7,168,811	4,776,166	4,779,208	836,787
Direct Contact Water Heater	1,856,188	1,856,188	1,857,370	1,237,459	1,238,247	216,803
Condensing Boiler (>300,000 Btu/h) (EF>90%) (Th. Eff. >=90%)	32,637	309,707	309,904	114,706	114,779	25,113
High Efficiency Steam Boiler (>300,000 Btu/h) (Th. Eff. >=80%)	251,634	808,619	809,134	215,632	215,769	47,210
Boiler Reset Controls	511,625	2,146,866	2,146,866	1,431,244	1,431,244	250,755

End Use	Technical Potential (MMBtu)	Economic Potential -UCT- (MMBtu)	Economic Potential -TRC- (MMBtu)	Achievable Potential -UCT- (MMBtu)	Achievable Potential -TRC- (MMBtu)	Constrained Achievable -UCT- (MMBtu)
Boiler Tune-Up	164,090	566,491	566,866	377,661	377,911	296,380
Regenerative Thermal Oxidizer vs. CTO	455,167	455,167	455,468	303,445	303,645	53,164
Direct Fired Make-up Air System	2,093,442	2,093,442	2,094,826	1,395,628	1,396,551	244,515
Improved Sensors & Process Controls	1,824,836	1,824,836	0	1,216,557	0	439,558
Boiler O2 Trim Controls	78,233	0	0	0	0	0
Electronic Parallel Positioning Controls (linkage less)	77,839	0	0	0	0	0
Waste-Heat Recovery	670,348	0	0	0	0	0
Facility HVAC						
Stack Heat Exchanger (Condensing Economizer)	644,080	644,080	644,080	429,387	429,387	84,917
Stack Heat Exchanger (Standard Economizer)	313,345	313,345	313,345	208,897	208,897	41,312
High Efficiency Furnace (<=300,000 Btu/h) (AFUE >=92%)	1,740,448	1,740,448	1,740,448	644,610	644,610	159,304
Infrared Heater (low intensity - two stage)	1,294,805	1,294,805	1,294,805	507,767	507,767	125,486
Direct Fired Make-up Air System	2,093,442	762,706	762,706	508,471	508,471	100,557
Gas Unit Heater - Condensing	801,522	801,522	801,522	242,885	242,885	60,025
Heat Recovery: Air to Air	642,257	0	0	0	0	0
Insulate and Seal Ducts (New Aerosl Duct Sealing)	585,285	0	0	0	0	0
Building Envelope						
Wall Insulation R-7.5 to R13	83,492	0	0	0	0	0
Integrated Building Design	5,244,118	0	0	0	0	0
Below Grade Insulation	5,159	0	0	0	0	0
Ceiling Insulation R-11 to R-42	237,785	237,785	0	0	0	0
Energy Efficient Windows	1,941,687	0	0	0	0	0
Roof Insulation R-11 to R-24	100,858	100,858	0	0	0	0
Ventilation						
Demand-Controlled Ventilation	813,419	0	813,419	0	431,466	0
Controled Ventilation Optimization	1,231,608	0	0	0	0	0
Improved Duct Sealing	91,878	156,297	130,674	66,157	55,312	16,472
Destratification Fan	61,002	103,772	86,760	62,263	52,056	12,351
HVAC Controls						
EMS Optimization	101,682	101,682	0	0	0	0
EMS install	240,576	240,576	0	0	0	0
Programmable Thermostats	151,521	151,521	162,747	114,565	123,053	22,528
Total	**41,436,733**	**30,680,739**	**28,922,334**	**17,022,073**	**16,218,312**	**3,685,220**
% of Annual Sales Forecast	**27.1%**	**20.0%**	**18.8%**	**11.1%**	**10.6%**	**2.4%**
Note: Measures in the above Table with "0" achievable potential are ones that did not pass the SCT Test.						

8.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

The tables below provide the net present value (NPV) benefits and costs associated with the three achievable potential scenarios for the industrial sector at the 5-year and 10-year periods. Tables 8-29 and 8-30 compare the 5 and 10 year NPV benefits and costs associated with the Achievable UCT and Achievable TRC Scenarios. Both the UCT and TRC scenario benefits include avoided energy supply and demand costs, while the Achievable TRC scenario benefits also include water savings benefits. The NPV costs in the Achievable UCT scenario includes only program administrator costs (incentives paid, staff labor, marketing, etc.) whereas the Achievable TRC scenario costs include both participant and program administrator costs.

Table 8-29: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Industrial Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$2,415,472,311	$1,588,409,007	1.52
Achievable TRC	$2,355,551,985	$904,530,823	2.60

Table 8-30: 10-Year Benefit-Cost Ratios for Achievable Potential Scenarios– Industrial Sector Only

10-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$4,079,323,484	$2,555,350,474	1.60
Achievable TRC	$3,892,555,420	$1,348,756,690	2.89

Tables 7-31 and 7-32 compare the NPV benefits and costs associated with the Achievable UCT and Constrained UCT Scenarios. Both scenarios compared the benefits and costs based the UCT. However the constrained scenario's 2% of revenue spending cap on DSM results in reduced program participation and overall NPV benefits.

Table 8-31: 5-Year Benefit-Cost Ratios for Achievable Potential Scenarios – Industrial Sector Only

5-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$2,415,472,311	$1,588,409,007	1.52
Constrained UCT	$546,280,808	$357,413,740	1.53

Table 8-32: 10-Year Benefit-Cost Ratios for Achievable Potential Scenarios– Industrial Sector Only

10-YEAR	NPV BENEFITS	NPV COSTS	B/C RATIO
Achievable UCT	$4,079,323,484	$2,555,350,474	1.60
Constrained UCT	$1,034,337,291	$640,256,627	1.62

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Tables 8-33 through 8-35.

Table 8-33: Annual Program Budgets Associated with the Achievable UCT Scenario (in millions)

ACHIEVABLE UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$113.6	$153.7	$174.0	$174.5	$135.0	$136.5	$119.3	$120.8	$121.3	$119.8
Admin.	$45.4	$61.5	$69.6	$69.8	$54.0	$54.6	$47.7	$48.3	$48.5	$47.9
Total Costs	***$159.0***	***$215.2***	***$243.6***	***$244.2***	***$189.0***	***$191.1***	***$167.1***	***$169.1***	***$169.8***	***$167.8***

Table 8-34: Annual Program Budgets Associated with the Achievable TRC Scenario (in millions)

ACHIEVABLE TRC	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$51.7	$89.4	$108.4	$108.5	$71.1	$71.3	$52.6	$52.8	$52.8	$52.9
Admin.	$20.7	$35.7	$43.3	$43.4	$28.4	$28.5	$21.0	$21.1	$21.1	$21.1
Total Costs	***$72.3***	***$125.1***	***$151.7***	***$152.0***	***$99.5***	***$99.9***	***$73.6***	***$74.0***	***$73.9***	***$74.0***

Table 8-35: Annual Program Budgets Associated with the Constrained UCT Scenario (in millions)

CONSTRAINED UCT	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Incentives	$32.8	$33.0	$33.6	$34.1	$34.7	$35.2	$35.8	$36.3	$36.9	$37.5
Admin.	$13.1	$13.2	$13.5	$13.7	$13.9	$14.1	$14.3	$14.5	$14.8	$15.0
Total Costs	***$45.9***	***$46.3***	***$47.1***	***$47.8***	***$48.6***	***$49.3***	***$50.1***	***$50.8***	***$51.6***	***$52.4***

APPENDIX A

APPENDIX B

APPENDIX C

Michigan Electric And Natural Gas Energy Efficiency Potential Study

Prepared for:

Michigan Public Service Commission

Consumers Energy

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Appendix C: Alternative Michigan Energy Savings Goals to Promote Longer Term Savings and Address Small Utility Challenges

Prepared by Optimal Energy

FINAL REPORT:

ALTERNATIVE MICHIGAN ENERGY SAVINGS GOALS TO PROMOTE LONGER TERM SAVINGS AND ADDRESS SMALL UTILITY CHALLENGES

Prepared for

Michigan Public Service Commission

MICHIGAN PUBLIC SERVICE COMMISSION

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Contents

INTRODUCTION

In Michigan and every other jurisdiction in North America policy-makers give utilities and/or non-utility administrators of efficiency programs a high level set of performance goals, usually including some measure of the amount of energy savings that will be produced. Ideally, those goals should be expressed in a manner that is most consistent with public policy objectives. That is, they would encourage efficiency program administrators to optimize their efficiency program portfolios in ways that maximize achievement of those objectives.

There are typically a wide range of policy objectives associated with legislative and/or regulatory requirements for utilities or non-utility administrators to promote end use efficiency. However, the most common and often the most important of those is to maximize net economic benefits. That is particularly important in jurisdictions in which spending on cost-effective efficiency programs is capped in some way.[1]

One important element affecting the value of efficiency investments is the longevity of the savings that the investments produce.[2] Some efficiency programs produce savings that are relatively short-lived, either because they rely on behavioral change that doesn't persist for long periods of time absent continued or additional efficiency program support, or because they promote measures that do not last very long before they wear out and need to be replaced. Examples of the latter are programs that promote the sale, purchase and/or installation of compact fluorescent light bulbs (CFLs), low flow showerheads and other hot water conservation measures, advanced or "smart" power strips, and steam traps. Other programs produce savings that are much longer-lived because they focus on measures that are either permanent (e.g. the orientation of a new building) or have very long lives (e.g. building insulation, HVAC equipment and some appliances).

Thus, ideally, savings goals should be articulated in ways that place greater value on longer-lived savings and less value on short-lived savings, or at least on capturing those savings that offer the largest lifecycle net economic benefits. Unfortunately, in Michigan and many other jurisdictions across North America, savings goals are expressed as the amount of savings that efficiency measures will produce just in their first year of functionality. That sends a less than ideal signal to utilities charged with designing and implementing efficiency programs. Specifically, it encourages them to maximize first year savings rather than maximizing lifetime savings or the value of the benefits provided over the entire lives of the efficiency measures.

Consider, for example, the hypothetical decision a utility must make when deciding whether to promote an efficiency measure that saves 20 therms of gas for just one year and costs $10 (i.e. $0.50 per unit of first year savings and $0.50 per unit of lifetime savings) or a measure

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[1] Some states require utilities or other program administrators to pursue all cost-effective efficiency investments regardless of budgetary requirements. While they endeavor to keep spending as low as possible, the obligation to capture all cost-effective efficiency is the over-riding obligation. In Michigan and many other states, spending is capped either legislatively or through regulatory processes.

[2] Longevity of savings is also closely related to other policy objectives, such as minimizing emissions of air pollutants.

that saves 100 therms per year for 20 years and costs $200 (i.e. $2.00 per unit of first year savings and $0.10 per unit of lifetime savings). All other things being equal, the low cost per unit of first year savings creates an incentive that encourages utilities to invest much more in the first measure even though the second measure provides five times as much value over its life.[3]

The Michigan Public Service Commission is keenly aware of this problem and has commissioned the Optimal team to help it assess alternatives to traditional first year savings goals. Using data from both DTE and Consumers Energy as well as some other states, this report provides several key pieces of information to help illuminate the issue:

1. <u>2012 Consumers Energy and DTE Efficiency Program Results</u>:
   We look at the overall portfolio-wide average measure life for each utility's electric and gas portfolios to provide a sense of the most recent year's mix of shorter-term and longer-term measures and programs. In addition, we calculate the cost per unit of annual and lifetime energy savings for individual programs and rank the programs to see which are the most and least expensive from an annual and lifetime perspective.
2. <u>2013 – 2015 Consumers Energy and DTE Efficiency Program Plans</u>:
   We examine the two utilities' previously filed plans, assessing which programs and which measures are expected to make the greatest contributions to the achievement of the utilities' goals for the period 2013 – 2015. This includes a comparison of future planned program mixes to the 2012 results to determine whether the mix of savings from longer-term and shorter-term measures is projected to change significantly for each utility over time.
3. <u>Jurisdictional Comparison</u>:
   We compare the average measure life of the Michigan utilities to those of utilities in several other jurisdictions, both in the Midwest and for a couple of nation-leading jurisdictions in New England to provide a sense of how the mix of short and long-term measures and programs of the two Michigan utilities compare to their peers.

Based on this analysis, we then describe a set of policy options for the Public Service Commission and other Michigan stakeholders to consider in order to reduce the bias to pursue savings that may be the most inexpensive from a first-year perspective, but not necessarily optimal in the longer-term.

Following this, we also explore another issue: whether savings goals are significantly more difficult for small cooperative and municipal utilities to achieve than for the larger investor-owned utilities. This analysis included reviewing current performance toward goals for all Michigan utilities, and analyzing whether performance appears to have a strong correlation with utility size and resources. We also considered the achievements of some small utilities outside of Michigan to inform this analysis.

[3] The factor of five is calculated without any discounting of future benefits. However, even if future benefits were discounted using a 5% real annual discount rate, the second measure would be far preferable, providing more than three times the lifetime benefits.

IMPACT OF FIRST-YEAR SAVINGS GOALS AND OPTIONS FOR CHANGING THEM

ANALYSIS OF 2012 DATA

DTE

The tables below show the data for annual and lifetime savings, as well as costs, for the DTE electric and gas efficiency programs.

Table 1: DTE 2012 Actual Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[4]

		Savings (MWh)			Program Cost/MWh			
Program	**Average Measure Life**	**Annual**	**Lifetime**	**Program Cost**	**Annual**	**Rank**	**Lifetime**	**Rank**
Residential								
HVAC	11.24	3,300	37,092	$1,000,000	$303	10	$27	8
Multifamily	9.42	10,900	102,678	$1,700,000	$156	7	$17	7
Administrative				$2,289,000				
Appliance Rec.	8.00	45,600	364,800	$4,400,000	$96	3	$12	6
Audit & Wx	9.63	17,700	170,451	$5,000,000	$282	8	$29	9
Low-Income	9.59	21,200	203,308	$6,200,000	$292	9	$30	10
ENERGY STAR	9.06	201,100	1,821,966	$12,100,000	$60	1	$7	1
Res. Subtotal	**9.01**	**299,800**	**2,700,295**	**$32,700,000**	**$109**		**$12**	
C&I								
Administrative				$2,216,000				
Non-Prescriptive	10.79	113,000	1,219,270	$13,400,000	$119	6	$11	5
Prescriptive	11.40	133,100	1,517,340	$12,200,000	$92	2	$8	2
C&I Subtotal	**11.09**	**246,100**	**2,729,249**	**$27,700,000**	**$113**		**$10**	
Ed. & Awareness	10.80	19,800	213,840	$2,200,000	$111	5	$10	4
Pilot Program	10.80	35,500	383,400	$3,900,000	$110	4	$10	3
TOTAL	**10.07**	**601,200**	**6,054,084**	**$69,700,000**	**$116**		**$12**	

[4] Energy Optimization 2012 Annual Report.

Table 2: DTE 2012 Actual Gas Savings (Thousand Mcf), Costs, $/Mcf, and Rank in $/Mcf by Program[5]

		Savings (Thousand Mcf)			Program Cost/Mcf			
Program	Average Measure Life	Annual	Lifetime	Program Cost	Annual	Rank	Lifetime	Rank
Residential								
ENERGY STAR	11.08	28.7	318	$300,000	$10.45	3	$0.94	4
Multifamily	15.61	49.1	766	$600,000	$12.22	4	$0.78	3
Low-Income	12.08	140.4	1,696	$6,000,000	$42.74	9	$3.54	9
Audit & Wx	15.11	200.8	3,034	$4,800,000	$23.90	7	$1.58	5
HVAC	15.06	225.3	3,393	$6,300,000	$27.96	8	$1.86	6
Administrative				$1,358,000				
Residential Subtotal	**14.29**	**644.4**	**9,208**	**$19,400,000**	**$30.11**		**$2.11**	
C&I								
C&I Non-Prescriptive	10.38	256.8	2,666	$1,800,000	$7.01	1	$0.68	1
C&I Prescriptive	10.62	464.4	4,932	$3,400,000	$7.32	2	$0.69	2
Administrative				$580,000				
C&I Subtotal	**10.53**	**721.2**	**7,598**	**$5,800,000**	**$8.04**		**$0.76**	
Education and Awareness	10.00	38.7	387	$800,000	$20.67	6	$2.07	8
Pilot Program	10.00	69.7	697	$1,400,000	$20.09	5	$2.01	7
TOTAL	**12.68**	**1,474**	**18,690**	**$28,600,000**	**$19.40**		**$1.53**	

At the program level, there does not appear to have been a dramatic difference between the ranking of electric or gas programs by dollars spent per unit of first year energy saved versus per unit of lifetime energy saved. Some programs exhibited a difference that is worth noting. For example, on the electric side, the Appliance Recycling Program was relatively inexpensive from a first-year savings perspective (rank = #3) but was more expensive from a lifetime perspective (rank = #6). The eight-year measure life is the shortest of any of the electric programs. This indicates that while the immediate savings that resulted from investing in this program may have been significant, the total long-term savings from these investments were relatively smaller. Similarly, on the gas side, the HVAC program moved up in the rankings when considered from a longer-term perspective. This program ranked near the bottom from a first-year perspective (rank = #8), but moves closer to the middle of the pack from a lifetime perspective (rank = #6) because of its relatively long measure life (15.06 years). However, the rankings of most other programs did not change much when comparing costs per unit of first year savings vs. costs per unit of lifetime savings. Put another way, most of the programs that

[5] Energy Optimization 2012 Annual Report.

were least expensive in terms of achieving first-year savings were also the least expensive for achieving longer-term (lifetime) savings.

That is not a surprising result when one considers that the range in average measure lives across the two program portfolios was relatively narrow (all electric programs have average lives between 8 and 11.4 years; all gas programs have lives between 10 and 15.6 years). However, as discussed further below, the range in measure lives across the utility's program portfolio can be expected to be more diverse in 2013 and beyond. The introduction of the residential behavior program with a measure life of just one year, by itself, significantly changes the range of average program lives.

Further, though not reflected in the DTE's plans, the reality of 2020 EISA lighting efficiency requirements effectively means that no new CFL installation will produce savings beyond 2020.[6] That means that though DTE's recent plan assumes CFLs will have a 9 year life regardless of the year in which they are installed, its 2013 program will produce savings for only 7 years, its 2014 program for only 6 years and its 2015 program for only 5 years. On the other end of the spectrum, the Michigan Efficiency Measures Database (MEMD) has measures life assumptions of just 20 years for measures like insulation which can remain unchanged in buildings for far longer periods. Many other jurisdictions assume at least a 25 or 30 year life for such measures. Shortening the lives of CFLs installed in future years, and increasing the lives of other long-lived measures for which such increases would be appropriate, could also start to affect the calculus of which programs in future years provide the biggest lifetime savings per dollar invested.

It is also important to understand that many of the programs listed in Tables 1 and 2 promote a wide variety of efficiency measures. Thus, it is possible that the current focus on first year savings might have led to the inclusion of substantial savings from some very short lived measures in some programs that dramatically reduces the overall weighted average program measure life. If this was the case, shifting just those few measures to longer lived measures could result in significant shifts in program rankings that are obscured by the more aggregated data. Given available data for 2012, we have not been able to tease out any such potential issues.

[6] CFL savings estimates are predicated on the assumption that they replace either incandescent or halogen lamps which have much shorter lives (typically on the order of 1 year) than CFLs (assumed in the MEMD to be 9 years). The 9 year savings life assumptions for CFLs implicitly assumes that had the incandescent or halogen not been replaced by a CFL, that the customer would have replaced burned out incandescent or halogen lamps with new incandescents or halogens for the next nine years. However, by 2020, when much more stringent lighting efficiency standards go into effect, the baseline scenario could no longer be continued replacement with incandescent or halogen lamps. Instead, most experts believe that they would have to purchase a CFL (or perhaps and LED) at that time. Thus, if incandescent or halogen lamps last only about a year, the measure life of a CFL cannot be longer than the period between when the CFL is installed and 2020 (or perhaps 2021 if one wanted to make assumptions about stockpiling of products before the new lighting standards go into effect).

Consumers Energy

The tables below show the data for annual and lifetime savings, as well as costs, for Consumers Energy's electric and gas efficiency programs.

Table 3: CE 2012 Actual Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[7]

Program	Average Measure Life	Savings (MWh) Annual	Savings (MWh) Lifetime	Program Cost	Cost/MWh Annual	Rank	Cost/MWh Lifetime	Rank
Residential								
ENERGY STAR Lighting	9.01	78,996	711,487	$6,203,651	$79	1	$9	1
ENERGY STAR Appliances	11.32	1,447	16,382	$277,610	$192	6	$17	6
HVAC and Water Heating	13.73	5,284	72,559	$2,179,519	$412	8	$30	8
Income Qualified	9.75	3,677	35,866	$1,563,654	$425	9	$44	9
Appliance Recycling	8.04	40,269	323,579	$4,153,407	$103	2	$13	5
Multifamily	9.74	6,127	59,700	$2,824,536	$461	10	$47	11
Think! Energy	9.64	2,244	21,631	$589,873	$263	7	$27	7
HP with ENERGY STAR	13.38	1,707	22,843	$3,537,620	$2,072	13	$155	13
Home Energy Analysis	9.14	4,852	44,362	$3,150,029	$649	11	$71	12
New Home Construction	17.39	179	3,121	$147,390	$821	12	$47	10
Residential Subtotal	**9.06**	**144,782**	**1,311,529**	**$24,627,289**	**$170**		**$19**	
C&I								
Comp. & Custom Bus. Solutions	12.12	145,367	1,761,853	$20,637,393	$142	5	$12	2
Small Business Direct Install	10.04	75,651	759,541	$9,508,822	$126	3	$13	4
Bus Multifamily Direct Install	10.67	5,365	57,240	$698,162	$130	4	$12	3
C&I Subtotal	**11.46**	**226,384**	**2,594,355**	**$30,844,377**	**$136**		**$12**	
TOTAL	**10.52**	**371,166**	**3,905,884**	**$55,471,666**	**$149**		**$14**	

[7] Residential Savings and Measure Lives: Cadmus, "Residential Energy Optimization Certification Report: 2012 Program Year." C&I Savings and Measure Lives: Correspondence from Benjamin M. Ruhl, August 2, 2013. Costs: Consumers Energy: 2012 Energy Optimization Annual Report.

Table 4: CE 2012 Actual Gas Savings (Thousand Mcf), Costs, $/Mcf, and Rank in $/Mcf by Program[8]

		Savings (Thousand Mcf)		Program Cost	Cost/Mcf			
Program	Average Measure Life	Annual	Lifetime		Annual	Rank	Lifetime	Rank
Residential								
ENERGY STAR Appliances	11.46	47.5	545	$243,367	$5.12	2	$0.45	2
HVAC and Water Heating	13.44	363.3	4,882	$8,164,392	$22.47	7	$1.67	6
Income Qualified	9.28	180.7	1,676	$10,463,836	$57.91	11	$6.24	11
Multifamily	9.81	230.3	2,258	$2,547,681	$11.06	4	$1.13	4
Think! Energy	12.00	50.9	610	$1,056,603	$20.77	6	$1.73	7
HP with ENERGY STAR	16.2	141.7	2,295	$6,087,006	$42.96	9	$2.65	10
Home Energy Analysis	10.26	109.3	1,122	$1,491,359	$13.64	5	$1.33	5
New Home Construction	18.68	8.5	158	$394,265	$46.63	10	$2.50	9
Residential Subtotal	**11.97**	**1,132.2**	**13,547**	**$30,448,509**	**$26.89**		**$2.25**	
C&I								
Comp. & Custom Bus Solutions	15.14	556.6	7,638	$6,054,667	$10.88	3	$0.79	3
Small Business Direct Install	9.43	475.9	4,383	$1,889,574	$3.97	1	$0.43	1
Bus Multifamily Direct Install	12.05	64.2	775	$1,506,954	$23.48	8	$1.95	8
C&I Subtotal	**11.67**	**1,096.6**	**12,796**	**$9,451,195**	$8.62		$0.74	
TOTAL	**11.82**	**2,228.8**	**26,343**	**$39,899,704**	**$17.90**		**$1.52**	

As was the case for DTE, there does not appear to have been a dramatic difference between the ranking of most electric or gas programs by dollars spent per unit of first year energy saved versus per unit of lifetime energy saved. There was one exception. Specifically, on the electric side, the Appliance Recycling Program was relatively inexpensive from a first-year savings perspective (rank = #2) but was more expensive from a lifetime perspective (rank = #5). The eight-year measure life is the shortest of any of the electric programs. This indicates that while the immediate savings that resulted from investing in this program may have been significant, the total long-term savings from these investments are relatively smaller. However, the rankings of most other programs did not change appreciably when comparing costs per unit of first year savings vs. costs per unit of lifetime savings. Put another way, most of the programs that were least expensive in terms of achieving first-year savings were also the least expensive for achieving longer-term (lifetime) savings.

Again, that is not a surprising result when one considers that, as was the case with DTE in 2012, the range in average measure lives across the two program portfolios was relatively

[8] Residential Savings and Measure Lives: Cadmus, "Residential Energy Optimization Certification Report: 2012 Program Year." C&I Savings and Measure Lives: Correspondence from Benjamin M. Ruhl, August 2, 2013. Costs: Consumers Energy: 2012 Energy Optimization Annual Report.

narrow. However, as mentioned above and discussed further below, the range in measure lives across the utility's program portfolio can be expected to grow in 2013 and beyond.

Further, though not reflected in Consumers' plans, the reality of 2020 EISA lighting efficiency requirements effectively means that no new CFL installation will produce savings beyond 2020.[9] That means that though Consumers' recent plan assumes CFLs will have a 9 year life regardless of the year in which they are installed, its 2013 program will produce savings for only 7 years, its 2014 program for only 6 years and its 2015 program for only 5 years. On the other end of the spectrum, the Michigan Efficiency Measures Database (MEMD) has measures life assumptions of just 20 years for measures like insulation which can remain unchanged in buildings for far longer periods. Many other jurisdictions assume at least a 25 or 30 year life for such measures. Shortening the lives of CFLs installed in future years, and increasing the lives of other long-lived measures for which such increases would be appropriate, could also start to affect the calculus of which programs in future years provide the biggest lifetime savings per dollar invested.

Again, as noted above, it is also important to understand that many of the programs listed in Tables 1 and 2 promote a wide variety of efficiency measures. Put another way, the average program measure life can mask significant differences between the lives of savings within the program. Given available data for 2012, we have not been able to tease out any such potential issues.

[9] CFL savings estimates are predicated on the assumption that they replace either incandescent or halogen lamps which have much shorter lives (typically on the order of 1 year) than CFLs (assumed in the MEMD to be 9 years). The 9 year savings life assumptions for CFLs implicitly assumes that had the incandescent or halogen not been replaced by a CFL, that the customer would have replaced burned out incandescent or halogen lamps with new incandescents or halogens for the next nine years. However, by 2020, when much more stringent lighting efficiency standards go into effect, the baseline scenario could no longer be continued replacement with incandescent or halogen lamps. Instead, most experts believe that they would have to purchase a CFL (or perhaps and LED) at that time. Thus, if incandescent or halogen lamps last only about a year, the measure life of a CFL cannot be longer than the period between when the CFL is installed and 2020 (or perhaps 2021 if one wanted to make assumptions about stockpiling of products before the new lighting standards go into effect).

2013 – 2015 FORECAST TRENDS

In this section we present the results of our analysis of the two utilities' forecast savings for 2013 to 2015. It should be noted that we have not verified that the assumptions used by the utilities in their forecasts are accurate or consistent with the Michigan Efficiency Measures Database (MEMD).[10]

DTE

In 2012, DTE filed an update to its 2012-2015 electric DSM plan. In the table below we present the forecast 2013 savings mix by program.

[10] We make this point in part because in reviewing Consumers' forecast savings by measure for 2013 through 2015 we noted that the forecast appeared to assume that most gas measures in its home retrofit program had a life of only 10 years. That is clearly too short for many measures, particularly insulation measures. This is the only example of a case in which we noticed something that appeared significantly "off". However, as noted, we did not attempt to conduct a thorough review of all assumptions in the measure-level forecast.

Table 5: DTE 2013 Forecast Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[11]

Program	Average Meas. Life	Savings (MWh) Annual	Savings (MWh) Lifetime	Program Cost	Program Cost/MWh Annual	Rank	Program Cost/MWh Lifetime	Rank
Residential								
Res. ENERGY STAR Products	8.8	143,956	1,261,815	$12,426,000	$86	2	$10	3
Appliance Recycling	8.0	34,687	277,496	$4,961,000	$143	8	$18	9
HVAC	15.0	2,526	37,973	$1,221,000	$483	17	$32	12
Multifamily	8.9	4,818	42,770	$1,479,000	$307	13	$35	13
Home Energy Consultation	9.1	8,247	75,183	$3,216,000	$390	15	$43	16
Audit and Weatherization	16.6	140	2,324	$469,000	$3,350	18	$202	18
School Program	9.0	2,735	24,615	$463,000	$169	11	$19	10
Behavior Programs	1.0	23,106	23,106	$2,229,000	$96	3	$96	17
Emerg. Meas. & Approaches	15.0	143	2,145	$910,000	$6,364	19	$424	19
Admin. & Infrastructure				$1,728,000				
Residential Subtotal	**7.9**	**220,358**	**1,746,209**	**$29,102,000**	**$132**		**$17**	
Low Income								
LI-Nonprofit	12.4	8,154	101,319	$3,835,000	$470	16	$38	14
LI-MF	8.9	2,405	21,349	$664,000	$276	12	$31	11
LI-HEC	9.1	6,109	55,692	$2,144,000	$351	14	$38	15
LI -Admin & Infrastructure				$677,000				
Low Income Subtotal	**10.7**	**16,668**	**178,016**	**$7,321,000**	**$439**		**$41**	
Commercial & Industrial (C&I)								
Prescriptive	11.8	108,903	1,283,651	$12,168,000	$112	4	$9	2
Non-Prescriptive	10.0	81,837	820,461	$13,580,000	$166	10	$17	8
Emerging Meas. & Approaches	10.0	5,286	52,860	$834,000	$158	9	$16	7
Energy Star Retail Lighting	2.0	28,214	56,428	$481,000	$17	1	$9	1
Multifamily Common Areas	10.3	5,482	56,280	$737,000	$134	7	$13	6
Admin. & Infrastructure				$1,655,000				
C&I Subtotal	**9.7**	**229,722**	**2,235,958**	**$29,455,000**	**$128**		**$13**	
Other Programs and Costs								
Pilot Program	10.0	25,968	259,680	$3,265,000	$126	6	$13	5
Education Program	10.0	15,581	155,810	$1,786,000	$115	5	$11	4
EM&V				$3,425,000				
Admin. & Infrastructure				$1,447,000				
Other Prog. & Costs Subtotal	**10.0**	**41,549**	**415,490**	**$9,923,000**	**$239**		**$24**	
TOTAL	**9.0**	**508,297**	**4,575,673**	**75,801,000**	**$149**		**$17**	

11 Costs and annual savings: Docket Number U-17049, Exhibit A-4 of witness V.M. Campbell. Lifetime savings and average measure lives based on measure level data provided in an Excel spreadsheet by DTE in response to NRDC/DE-6 in U-17049.

The average measure life of DTE's efficiency portfolio savings is forecast to be about 10% lower in the 2013 than it was in 2012. Three factors appear to drive this change. The first is the addition of a full scale residential behavior program (O Power) which is forecast to provide about 4% of total first year saving, but with a savings life of just one year. The second is the addition of a C&I retail lighting program which is forecast to provide approximately 5% of total first years savings, but with a savings life of just two years. As Table 5 shows, the addition of these two programs illustrates how the relative rank of a program in cost per first year savings can be very different than the rank in terms of cost per lifetime savings. Finally, DTE has estimated that an average measure life of 10 years for the 2013 C&I non-prescriptive program – a little lower than the nearly 10.8 year average life experienced in 2012. This could be a result of choices to include more short-lived measures encouraged by the current goals structure, but that would require more detailed analysis at the measure level to confirm.

In general, the mix of savings forecast by DTE for 2014 and 2015 is very similar to the mix shown above for 2013. As a result, the average measure life for the portfolio of savings is forecast by DTE to be very similar (only very slightly higher) in 2014 and 2015 to what it is forecast to be for 2012. The four year trend in average measure life from 2012 through 2015 is provided in the table below.

Table 6: DTE Portfolio-Level Electric Average Measure Life, 2012 - 2015

Year	2012	2013	2014	2015
Average Life	10.1	9.0	9.2	9.2

As noted above, some similarities in the ranking of efficiency programs by cost per unit of first year savings and cost per unit of lifetime savings may mask significant differences between measures within programs. In other words, the effect of articulating goals as lifetime savings rather than as first year savings may be even greater than suggested by the program comparisons provided above. We have not conducted an exhaustive assessment of the potential impacts at the measure level. However, to gain some insight into that issue we did look at how the ranking of measures within DTE's C&I Prescriptive program forecast for 2013 (in terms of rebate cost per unit of savings) changed when moving from a focus on first year savings to a focus on annual savings. Table 7 shows 12 program measures whose rank changed by more than 50% (in either direction) when shifting from a rebate per first year savings metric to a rebate per lifetime savings metric. Some changed quite substantially. For example, high performance glazing was the 81st cheapest measure in terms of rebate cost per first year kWh saved, but 33rd cheapest per lifetime kWh saved.[12] If the assumed life for this measure was increased to 30 years (20 seems conservative, at least for some types of commercial buildings), it would move into the top 15 measures in terms of cost per lifetime kWh. At the other end of the spectrum, low watt T8 lamps, which rank 14th and 15th per first year kWh, rank 73rd and 74th per lifetime kWh. These examples illustrate why it may be plausible that the utilities would

[12] There were 117 C&I Prescriptive program measures analyzed in DTE's most recent EO plan. Some of the measures are simply different variations (by size, applicable market, applicable baseline condition, etc.) of the same technology. Thus, the number of measure types is considerably smaller.

consider not only changing their emphasis on different programs if a lifetime savings goal was adopted, but also consider changing emphasis on different measures within programs.

Table 7: Selected DTE Forecast 2013 C&I Prescriptive Program Measure Rankings (Incentive $/kWh)

Measure	Measure Life	Incentives $ per kWh Saved		Measure Rank (out of 117)	
		1st Year	Lifetime	1st Year	Lifetime
Barrel Wraps Inj Mold and Extruders	5	0.0222	0.0044	4	13
Low Watt T8 lamps	5	0.0556	0.0111	14	73
LW T8 U-Lamp, replacing Standard T8	5	0.0556	0.0111	15	74
Anti Sweat Heater Control	15	0.0597	0.0040	22	9
ECM Motors for Walk-in Refrigeration Cases	15	0.0651	0.0043	24	12
LED Exit Signs Electronic Fixtures (Retrofit Only)	15	0.0691	0.0046	26	16
LED Refrigerated Case Lighting	16	0.0725	0.0045	31	14
Motors 1 to 5 HP	15	0.0736	0.0049	33	19
LED Auto Traffic Signals	6	0.0808	0.0135	35	81
Night Covers (vertical)	5	0.0831	0.0166	42	87
LED recessed down light - ENERGY STAR qualified	15	0.0855	0.0057	45	29
High Performance Glazing CI E	20	0.1333	0.0067	81	33

Consumers Energy

In 2011, Consumers filed its plan for 2012 through 2015. In the tables below we present the forecast 2013 savings mix by program.

Table 8: CE 2013 Forecast Electric Savings, Costs, $/MWh, and Rank in $/MWh by Program[13]

		Savings (MWh)			Program Cost/MWh			
Program	Average Measure Life	Annual	Lifetime	Program Cost	Annual	Rank	Lifetime	Rank
Residential								
Appliance Recycling	8.2	43,840	357,905	$3,908,231	$89	2	$11	3
Energy Education	9.0	1,846	16,614	$595,197	$322	8	$36	8
Multifamily Direct Install	9.1	5,758	52,285	$3,792,197	$659	10	$73	11
Energy Star Appliances	10.2	877	8,965	$407,277	$464	9	$45	9
Energy Star Lighting	9.0	59,439	535,061	$4,823,220	$81	1	$9	1
HVAC and Water Heating	10.5	4,842	50,983	$3,570,035	$737	11	$70	10
Inc. Qualified Assistance	8.8	1,540	13,481	$1,520,858	$988	12	$113	12
New Construction	13.0	101	1,313	$242,808	$2,404	13	$185	13
Existing Home Retrofit	9.2	21,251	196,071	$5,418,296	$255	6	$28	7
Residential Pilots	10.0	6,322	63,220	$1,456,285	$230	5	$23	6
Residential Subtotal	**8.9**	**145,816**	**1,295,899**	**$25,734,403**	**$176**		**$20**	
Business				$0				
Custom & Prescriptive	12.5	210,142	2,621,193	$23,918,655	$114	3	$9	2
Small Bus. Direct Install	12.1	31,110	374,876	$8,280,094	$266	7	$22	5
Business Pilots	11.0	10,536	115,896	$1,855,571	$176	4	$16	4
Business Subtotal	**12.4**	**251,788**	**3,111,965**	**$34,054,320**	**$135**		**$11**	
TOTAL	**11.1**	**397,604**	**4,407,864**	**$59,788,724**	**$150**		**$14**	

[13] Costs and annual savings: Consumers Energy 2012-2015 Amended Energy Optimization Plan. Lifetime savings and average measure lives based on measure level data provided by Consumers in response to NRDC data request #23 in MPSC Case No. U-16670.

Table 9: CE 2013 Forecast Gas Savings (Thousand Mcf), Costs, $/Mcf, and Rank in $/Mcf by Program[14]

Program	Average Measure Life	Savings (Thousand Mcf) Annual	Savings (Thousand Mcf) Lifetime	Program Cost	Program Cost/Mcf Annual	Rank	Program Cost/Mcf Lifetime	Rank
Residential								
Appliance Recycling	10.0	17.3	173	$99,019	$5.72	2	$0.57	3
Energy Education	12.0	31.8	381	$980,712	$30.88	10	$2.57	11
Multifamily Direct Install	12.3	272.2	3,337	$2,316,511	$8.51	4	$0.69	4
Energy Star Appliances	12.0	95.9	1,148	$204,233	$2.13	1	$0.18	1
HVAC and Water Heating	15.8	423.4	6,686	$9,272,221	$21.90	7	$1.39	7
Inc. Qualified Assistance	12.9	64.4	831	$9,928,667	$154.25	12	$11.95	12
New Construction	13.0	6.4	83	$249,380	$39.12	11	$3.01	10
Existing Home Retrofit	10.6	274.5	2,910	$6,036,507	$21.99	8	$2.08	8
Residential Pilots	10.0	58.7	587	$1,687,544	$28.77	9	$2.88	9
Residential Subtotal	**13.0**	**1,244.5**	**16,136**	**$30,840,072**	**$24.78**		$1.91	
Business								
Custom & Prescriptive	12.3	728.1	8,920	$8,737,465	$12.00	5	$0.98	5
Small Bus. Direct Install	8.9	127.5	1,133	$1,046,694	$8.21	3	$0.92	2
Business Pilots	11.0	33.4	368	$579,638	$17.33	6	$1.58	6
Business Subtotal	**11.7**	**889.1**	10,421	**$10,363,797**	**$11.66**		**$1.00**	
TOTAL	**12.4**	**2,133.6**	**26,556**	**$41,203,868**	**$19.31**		**$1.55**	

In general, the mix of savings forecast by Consumers for 2014 and 2015 is very similar to the mix shown above for 2013. As a result, the average measure life for the portfolio of savings is forecast by Consumers to be nearly identical in 2014 and 2015 to what it is forecast to be for 2013. The four year trend in average measure life from 2012 through 2015 is provided in the tables below. For both electricity and gas it appears as if Consumers' is projecting that average measure lives will increase modestly over 2012 levels.

[14] Costs and annual savings: Consumers Energy 2012-2015 Amended Energy Optimization Plan. Lifetime savings and average measure lives based on measure level data provided by Consumers in response to NRDC data request #23 in MPSC Case No. U-16670.

Table 10: CE Portfolio-Level Electric Average Measure Life, 2012 - 2015

Year	2012	2013	2014	2015
Average Life	10.5	11.1	11.1	11.1

Table 11: CE Portfolio-Level Gas Average Measure Life, 2012 - 2015

Year	2012	2013	2014	2015
Average Life	11.8	12.4	12.3	12.2

As noted above, some similarities in the ranking of efficiency programs by cost per unit of first year savings and cost per unit of lifetime savings may mask significant differences between measures within programs. In other words, the effect of articulating goals as lifetime savings rather than as first year savings may be even greater than suggested by the program comparisons provided above. We have not conducted an exhaustive assessment of the potential impacts at the measure level. However, to gain some insight into that issue we did look at how the ranking of measures within CE's C&I Prescriptive program forecast for 2013 (in terms of rebate cost per unit of savings) changed when moving from a focus on first year savings to a focus on annual savings. Table 12 shows 12 program measures whose rank changed by more than 50% (in either direction) when shifting from a rebate per first year savings metric to a rebate per lifetime savings metric. Some changed quite substantially. For example, specialty CFLs were the 5th cheapest measure in terms of rebate cost per first year kWh saved, but 41st cheapest (out of 49 measures) per lifetime kWh saved.[15] These examples illustrate why it may be plausible that the utilities would consider not only changing their emphasis on different programs if a lifetime savings goal was adopted, but also consider changing emphasis on different measures within programs.

[15] There were 117 C&I Presciptive program measures analyzed in DTE's most recent EO plan. Some of the measures are simply different variations (by size, applicable market, applicable baseline condition, etc.) of the same technology. Thus, the number of measure types is considerably smaller.

Table 12: Selected CE Forecast 2013 C&I Prescriptive Program Measure Rankings (Incentive $/kWh)

Measure	Measure Life	Incentive $ per kWh Saved		Measure Rank (out of 49)	
		1st Year	Lifetime	1st Year	Lifetime
CFL Screw in (30 watts or less) P - 2013	2	0.0104	0.0052	2	11
Compact Fluorescents: Screw-in, 31-115 W	2	0.0177	0.0089	3	23
4-foot Standard T8 to Reduced Wattage T8 (lamp only)	12	0.0358	0.0030	4	2
CFL Specialty (down-light, 3-way, dimmable)	2	0.0404	0.0202	5	41
VFD on HVAC Fans and Pumps	15	0.0542	0.0036	6	3
Network Power Management Software	5	0.0565	0.0113	7	31
Recessed Downlight Fixture (LED)	15	0.0570	0.0038	8	4
Anti Sweat Heater Controls	15	0.0597	0.0040	10	5
VFD for Process Pumping, <= 50 HP	15	0.0620	0.0041	11	6
Demand Control Ventilation - Electric Customers	15	0.0643	0.0043	13	7
Demand Control Ventilation - Combination Customers	15	0.0648	0.0043	14	8
LED, T-1, or Electroluminescent Exit Signs	15	0.0689	0.0046	16	9

JURISDICTIONAL COMPARISON

In the table below we provide a comparison between the 2012 actual and 2013 to 2015 forecast average electric efficiency portfolio savings life for DTE, Consumers and several other efficiency program administrators in New England and the Midwest. It should be noted that it is not always very easy to obtain such information because it is not commonly reported. Indeed, we do not have sufficient data from other jurisdictions to present a comparable table for gas efficiency program portfolios. This underscores the reality that Michigan's historic focus on first year savings is not unique to the state or even its region.

Table 73: Electric Average Measure Lives in Various Jurisdictions

Program Administrator	Source	2012	2013	2014	2015
DTE	2012 Actuals, 2013-15 Plan	10.1	8.8	9.0	9.0
Consumers Energy	2012 Actuals, 2013-15 Plan	10.5	11.1	11.1	11.1
Efficiency Vermont[16]	2012 Actuals	11.2	n.a.	n.a.	n.a.
NSTAR (MA)[17]	2012 Actuals	11.7	n.a.	n.a.	n.a.
Commonwealth Edison (IL)[18]	PY4-PY6 Plan 6/2011 to 5/2014)	8.6	n.a.		
Focus on Energy (WI)[19]	2012 Actuals	11.0	n.a.	n.a.	n.a.

Average measures lives for the six program administrators for which we've acquired data range from a little less than 9 years to a little more than 12 years. DTE's forecast average measure life for 2013 to 2015 is at the low end of that range and notably about 20% lower than Consumers' average for the same time period. Consumers' average life appears to be consistent with most of the others. However, it should be emphasized that average measure life calculations for portfolios of efficiency programs are necessarily a function of assumptions used for the savings lives of many different efficiency measures. While Consumers and DTE presumably use the same MEMD assumptions, some of the differences between their average portfolio savings lives and those of program administrators in other jurisdictions might be a function of different assumptions for the same measures. As discussed above, there are examples in the MEMD of measure life assumptions which appear to be conservatively low (e.g. insulation measures) as well as examples that appear to be high (e.g. CFLs). We recommend that these and perhaps some other lifetime assumptions in the MEMD be re-examined, particularly if Michigan policies begin placing more emphasis on lifetime savings.

OPTIONS FOR REMOVING BIAS TO PURSUE CHEAP SHORT-LIVED SAVINGS

Ultimately, there are two policy "levers" for addressing these perverse incentives to pursue short-term savings that are inherent in goals articulated as first year savings. The first is to redefine savings goals in a way that encourages greater consideration of the lifetime benefits of efficiency measures. The second is to establish shareholder incentive metrics that do the same thing. In general, we believe both should be changed, starting with the goals themselves because they are the root of the problem. If the goals are unchanged (i.e. remain articulated as first year savings) and utilities are provided shareholder incentives that are based on some measure of lifetime savings or benefits, they will perceive themselves as being in the position of having to meet two different, sometimes competing, objectives. That would likely lead to some

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[16] Efficiency Vermont 2012 Savings Claim Summary.

[17] Northeast Utilities (parent of NSTAR), "Energy Efficiency Programs," http://www.nu.com/responsible_energy/our-business/energy-efficiency-programs.html.

[18] Based on lifetime savings data over the PY4 to PY6 plan period provided by Com Ed in a personal communication. Lifetime savings were divided by annual savings for the same plan period as filed by Com Ed in Illinois Docket Number 10-0570.

[19] The Cadmus Group, Focus on Energy Calendar Year 2012 Evaluation Report, Volume 1; April 30, 2013.

improvement in outcomes (i.e. more investment in long-live savings), but not as much as if the fundamental goals were corrected or changed.

There are several different ways to adjust savings goals so that they better encourage utilities to maximize the lifetime benefits of efficiency programs. What follows is a discussion of the following options:

1. Lifetime savings goals
2. Discounted lifetime savings goals
3. Net present value of net benefits
4. Cumulative annual savings goals over a multi-year period
5. 1st year savings goals with limits on quantity of savings from short-lived measures
6. 1st year savings goals with bonuses/penalties for long/short-lived measures
7. 1st year savings goal with average measure life adjustment factor

Lifetime Savings

Under a lifetime savings goal, program administrators' performance would be measured relative to the total savings they produce over the life of the efficiency measures that they cause to have installed. For example, if a furnace saves 100 therms of gas per year for 20 years, then the lifetime savings for that measure would be 2000 therms.

The advantages of this metric of performance are that it is conceptually easy to explain and understand, simple to calculate using data that program administrators already routinely collect and evaluate (all TRMs have both annual savings and measure life as key components), and clearly values all of the savings that efficiency measures will produce over their lives. It also preserves utility flexibility in being able to choose a balanced portfolio that can support short-lived measures as well, if appropriate, so long as they have a plan that meets the overall target.

Depending on one's perspective, there is one *potential* disadvantage to this metric: it treats savings 10 or 20 years from now as just as valuable as savings this year. Put another way, it does not discount the value of future years' savings. Thus, while it fixes the problem that first year savings goals have of not valuing future years' savings at all, relative to the net present value calculation that is typically used for cost-effectiveness screening, a lifetime savings goal *may* sometimes over-value future years' benefits. We say sometimes "*may*" rather than "*will*" because the avoided costs used to value savings can also change over time and are often higher in the long term than in the short term. If avoided costs are increasing at roughly the same annual rate as the discount rate, a lifetime savings metric would be a very good proxy for the economic benefits of efficiency investments.

The Canadian province of Ontario began using lifetime savings in 2012 as its principal metric for measuring the effectiveness of its two gas utilities' efficiency program performance. The Wisconsin Focus on Energy program switched to goals expressed as lifetime savings in 2013.

Discounted Lifetime Savings

Discounted lifetime savings is the same as the lifetime savings metric except that a real discount rate (i.e. excluding inflationary effects) is applied to future year savings so that the farther out in time you go the less value is attached to each year's worth of savings. For example, using a 5% real discount rate, an efficient furnace that saved 100 therms/year for 20 years would have a discounted lifetime value of 1309 therms.[20]

As with the lifetime savings metric discussed above, this metric clearly values all of the savings that efficiency measures will produce over their lives rather than just the first year of savings. One *potential* additional advantage of this metric *could* be a better reflection of the economic value of the savings because savings that will occur many years out in the future would be valued less than those that occur in the near term. Economists – and most consumers – value a dollar today more than a dollar they will receive next year and value a dollar they will receive next year more than a dollar they will receive in ten years. However, it is important to remember that savings are not necessarily the same as dollars. Their value is a function of *both* how far out in the future they will occur and what the utility's avoided costs are in future years. Changes in forecast avoided costs over time could potentially offset (or even more than offset) the effects of discounting, so discounting will not necessarily lead to more accurate valuing of future year savings.

One major disadvantage of using discounted lifetime saving is that it is complicated. It would require additional development of discounting factors for every different possible measure life (i.e. rather than just multiplying annual savings by measure life to obtain lifetime savings, you must also multiply that product by a discounting factor that is a function of measure life and discount rate). Further, those discounting factors could change over time as the real discount rate changes.[21] They may also be different even between utilities in the same state, making comparisons of performance difficult. Another important disadvantage is that it is difficult to explain and understand. Finally, as discussed above, depending on how avoided costs change over time, discounted lifetime savings may not be a more accurate reflection of the lifecycle value of efficiency than undiscounted lifetime savings. Many experts believe that concerns about climate change are likely to make efficiency savings in the longer term even more important than today, and that additional costs not fully captured now in avoided costs will likely be imposed (e.g., a carbon tax). This would also lead one to consider not discounting physical units of future savings as inappropriately discounting efficiency resources that may actually be worth more in the future than current models suggest.

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[20] Using a 5% discount rate, 1 unit of savings is worth 13.09 units over 20 years, 10.90 units over 15 years, 8.11 units over 10 years and 4.55 units over 5 years.

[21] A utility's cost of capital is often used as a nominal discount rate. However, that can change over time – as can the inflation rate which needs to be subtracted from it to produce a real discount rate.

We are not aware of any jurisdiction that uses discounted lifetime savings as a performance target.

Net Present Value of Net Benefits

In one sense, the best way to ensure that savings from both short and long-lived measures are valued in proportion to the benefits that they provide is to base goals on the computation of net economic benefits. Such calculations are routinely performed in most jurisdictions to justify programs during the planning process and to retrospectively assess the benefits that were actually achieved.

The obvious advantage of this approach is that it adjusts not only for the live of the savings, but also for the value to the system of savings in different years, the value of savings during different seasons and times of day, and for the cost of acquiring the savings.

However, there are a variety of disadvantages of using this approach to set high level goals. First, the very attributes that ensure that it provides exactly the right weighting to different measures also ensure that it would be complex to administer, with the potential for significant disagreements over not only annual savings levels and measures lives, but also avoided costs, load shapes, measure costs, etc. That can add significantly to annual savings verification processes. Second, it is unclear how to objectively set economic benefits targets without extensive analysis. There is a wealth of information on how difficult different levels of first year savings are to achieve from numerous states. There is almost as much information regarding typical portfolio average measure lives. Both sets of insights are largely transferable from one jurisdiction to the next. There is much less information about what it takes to achieve $100 million in net benefits. Moreover, because of significant variations in avoided costs, any such information could be difficult to transfer from one jurisdiction to another. Third, the key variable of avoided costs can differ between utilities in the same state and change non-trivially from year to year. That makes it difficult to benchmark and adopt a single metric for an entire jurisdiction, to determine appropriate goals for more than a year or two at a time, or to assess trends in performance over time. We believe this is problematic because, while in theory goals based on net benefits can be adjusted annually whenever avoided costs change, and adjusted between utilities with differing avoided costs, we believe this would add unnecessary transactional costs and analyses, and reduce the overall transparency of the Michigan efficiency efforts and direct comparability between utility performance.

The province of Ontario used to use TRC net benefits as the principal performance metric for its gas portfolio, but switched to lifetime savings in 2012 in large part because of direct experience with the concerns articulated above. Some other jurisdictions (e.g. Connecticut, Massachusetts and Vermont) have net or gross economic benefits as one of the metrics used to judge program administrators' performance, but our experience has been that those metrics are usually established by first setting a 1st year savings target, determining how that target is likely to be met or could be met with an acceptable mix of programs, and then calculating the economic benefits that mix of programs would produce. In other words, such goals are usually driven primarily by first year savings goals rather than developed independently.

Cumulative Annual Savings over Multi-Year Period

Under a cumulative annual savings goal, an efficiency program administrator would be measured relative to the annual savings that are still being realized in the final year of a multi-year period. For example, if a program administrator caused one efficient furnace that produced 100 therms of savings for 20 years to be installed in each of the five years of a program (five furnaces total), then the cumulative annual savings in year 5 would be 500 therms. On the other hand, if a program designed to influence efficiency or conservation behavior produced 10 therms of savings that lasted only one year, after five years of implementation of the program the cumulative annual savings would still only be 10 therms because only the savings produced in year 5 would still be in effect in year 5 (savings produced from the program in years 1, 2, 3 and 4 would have ended).

The principal advantage of this type of metric is that it discounts the savings produced in the early years of a multi-year period by measures with very short lives.[22] An additional side benefit – not associated with trying to promote long-lived measures – is that multi-year goals offer program administrators greater flexibility in designing and managing their efficiency programs.

However, there are a number of disadvantages with regard to addressing the lifecycle benefits of efficiency measures. First, the metric will not make any distinction between the value of measures with moderate lives and the value of those with long or very long lives. Most jurisdictions are unlikely to establish goals over multi-year periods of more than five years. Thus, even for measures implemented in the first year of a multi-year period, there would be no difference in value assigned to measures with lives of 5 years relative to measures that will produce savings for 10, 20 or 30 years. Moreover, as you progress through a multi-year period the cumulative annual savings metric will not even discount the benefits of the most short-lived measures. For example, in the last year of a multi-year period, a behavior program that produces savings with a life of only one year will be valued just as much as a program that produces savings over 10, 20 or 30 years. Finally, this type of approach can create perverse

[22] Note that this is the only advantage associated with the cumulative annual savings aspect of this type of goal. There are other advantages of having multi-year goals rather than annual goals. These include the ability to manage variability in market response to programs over time, better incentives to address efficiency opportunities that take a number of years to reach fruition, better incentives to invest in research and development and better incentives to invest in program approaches that may cost more in the short run per unit of savings realized but have good pay-offs over a longer-term. We don't focus on those advantages here because they are not unique to a cumulative annual savings goal. One could have, for example, a multi-year goal that is focused on lifetime savings (i.e. where lifetime savings achieved through programs run over a 3 or 5 year period are the metric of concern) rather than cumulative annual savings. Indeed, there are jurisdictions (e.g. Vermont) which have multi-year (3 years in Vermont's case) targets that focus on the sum of first year (not cumulative and still persisting) annual savings.

incentives both early in the period as well as toward the end of the period, unless it is somehow combined with annual goals. For example, all things being equal a goal-maximizing utility would decline to promote *any measure with a measure life shorter than the remaining period no matter how cost-effective it might be, and then pursue as much of that short-lived measure in the last year or few years of the period, even it is was relatively more expensive on a life-cycle basis.* An example of this would be for a utility to pursue no behavioral programs in years 1-4, and then shift a large portion of its portfolio to investing in a behavior program only in year 5. Not only would this likely result in worse long term net benefits maximization, but limits the benefits of consistency in terms of customer and trade ally marketing and relations, and the effects of market transformation over time.

The European Union recently adopted a cumulative annual savings obligation covering the period 2014 through 2020.

1st Year Savings Goals with Limits on Savings from Short-Lived Measures

One option to address concerns that goals expressed as 1st year savings provide inappropriate incentives to promote inexpensive short-lived savings is to put a cap on the amount of savings from such measures that can be counted towards the first year savings target. For example, one could require that no more than 10% of savings come from measures with lives of five years or less.

This approach has the obvious advantage of curbing incentives that first year savings targets provide to promote inexpensive and very short-lived savings. It is also relatively simple and easy to understand. Finally, it maintains the principal advantage of continuing to express savings in first year terms – namely, that first year savings are easy to understand and easy to put into context. In particular, when savings targets are expressed as a percent of annual energy sales, it is easy for everyone to understand how much of a contribution new savings from a set of programs is contributing to overall energy needs.[23]

However, there are disadvantages to this approach as well. In short, it is a blunt instrument. Consider the example provided above. If the only constraint imposed is a limit on the amount of savings from measures with a life of five years or less, no distinction is made between measures with lives of 6 or 7 years and measures with lives of 20 or 30 years, even though savings from the latter group can last three to four times as long as savings from the former group. Similarly, no distinction is made between measures with lives of 1 or 5 years, even though savings from the latter group are worth five times as much as savings from the former group. This problem can theoretically be reduced by having a number of different constraints (see discussion below). However, as the number constraints increases, the administrative complexity for an efficiency program portfolio also increases. Another disadvantage of a limit on short-term savings is that it doesn't distinguish between the relative cost-effectiveness of different short-lived efficiency measures. If an efficiency measure with a life of only one or two years is very inexpensive per unit of first year savings, but relatively expensive per unit of

[23] Though what should really matter is what cumulative annual savings are as a percent of sales over a multi-year period, as that is most relevant to longer-term planning.

lifetime savings, then finding a way to limit the promotion of that measure (absent a mandate to pursue all cost-effective savings) may be a good idea. Alternatively, if an efficiency measure with a life of five years is not only very inexpensive per unit of first year savings but also has by far the lowest cost per unit of lifetime savings, then constraining its promotion would work against overall policy objectives.

The approach to limiting the portion of savings that can come from short-lived measures has been used in several European countries.

1st Year Savings Goals with Bonuses/Penalties for Long/Short-Lived Measures

Another option for addressing concerns about the signals that a 1st year savings goal send, without fully jettisoning the use of a 1st year savings goal, is to provide bonuses for long-lived measures and penalties for short-lived measures. For example, one could require that 1st year savings from measures with lives of 5 years or less be multiplied by 0.5 and savings from measures with lives of 15 years or more to be multiplied by 1.5. Under such a scheme, an efficient furnace that saves 100 therms/year for 20 years would count as 150 therms towards a first year savings target and a behavior program that saved 20 therms for only one year would count as 10 therms towards the first year savings target.

This approach has the obvious advantages of reducing incentives to promote resources that are inexpensive on a first year basis but that are not (relatively) as cost-effective on a lifecycle basis while increasing incentives for resources that are cheaper on a life-cycle basis. It also maintains the principal advantage of expressing savings in first year terms – that first year savings are easy to understand and easy to put into context.

However, it is still a somewhat blunt instrument. If there is a single threshold for defining a "short-lived measure" and a single penalty multiplier for such measures, as well as a single threshold for defining a long-lived measure, some perverse signals can be sent. For example, in the example provided above, a program administrator would consider a measure with a life of 6 years to be more than twice as valuable as a measure with a life of 5 years (2.5 after the 50% multiplier is applied). On the other hand, the program administrator would see the same value in a measure with a life of one year as in a measure with a life of 5 years and the same value in a measure with a life of 6 years as in a measure with the live of 14 years. Among other things, this will also put a lot of pressure on the determination of appropriate measure life assumptions for measures that are at or very close to the threshold levels for penalties and bonuses.

This approach of providing penalty multipliers to short-lived measures and bonus multipliers to long-live measures has been used in Denmark (measures with a life of less than 4 years got a 0.5 multiplier and some[24] measures with a life of over 15 years got a 1.5 multiplier.)

[24] The 1.5 multiplier applied only to measures with lives of over 15 years that saved fuels not covered by a carbon emissions cap and trading system.

1st Year Savings Goal with Average Measure Life Adjustment Factor

A third way to continue to use 1st years savings as the way of expressing savings goals while sending better signals regarding the longevity of savings is to establish an average measure life expectation and related total savings adjustment factor that is applied at the portfolio level, along with the 1st year savings target. For example, if the goal was to achieve first year savings of 100,000 MWh with an average life of 10 years, and the program administrator achieved only 90,000 but with an average life of 12 years, the savings achieved would be given a 20% bonus (i.e. a multiplier of 12 divided by the expected 10) and the goal would have been exceeded (108,000 MWh after adjustment). Conversely, if 110,000 MWh of first year savings was achieved but with an average measure life of only 8 years, a 20% penalty (i.e. a multiplier of 8 divided by the expected 10) would be applied to the savings and the goal would not have been met (88,000 MWh after adjustment).

This approach is functionally the same as setting a lifetime savings target, except that it builds on an explicit 1st year savings goal and an average measure life expectation. The scalable nature of the adjustment factor eliminates any of the disadvantages associated with the "blunt instruments" described above. Thus, it retains the communication advantages of a 1st year savings goal while providing exactly the right level of incentive to all efficiency measures regardless of their useful life – a 3-year measure is worth exactly three times as much as a 1-year measure; a 10-year measure is worth exactly twice as much as a 5-year measure; an 18-year measure is worth exactly three times as much as a 6-year measure; etc. Further, we believe that preserving consistency with expressing goals as annual has some value for purposes of transparency, comparability among jurisdictions, and potentially for legal and regulatory reasons.

We do not see any significant disadvantages to this approach. However, we are unaware of any jurisdictions that have adopted it to date.

Summary

There are a variety of different approaches one could use to either change first year savings goals or replace them with alternative metrics (like lifetimes savings goals), each of which has different advantages and disadvantages which we have discussed above. Note that the examples we used in the discussions were illustrative only.

Ultimately, our view is that the last option discussed – a first year savings goal with an average measure life assumption and related, proportional first year savings adjustment factor applied at the portfolio level – is the best. It strikes the best balance between clarity of objectives, ease of implementation and sending the right signals regarding the relative benefits of measures with different lives.

Note that it is also possible to combine some of the approaches discussed above. For example, one could combine the use of first year savings goals with average measure life adjustment factors (our preferred approach) with a multi-year savings target. Under this example, utilities could be required to meet a four-year savings goal of 4% with an average measure life of 12 years and proportional adjustments for deviations from that average life,[25] rather than having four one-year goals of 1% savings with the same 12 year measure life adjustment factor.[26] That combination would provide the benefits of the measure life adjustment factor approach while also providing utilities with the flexibility advantages of a multi-year savings target.

[25] Under this approach, we presume that first year savings would still be calculated and adjusted (using the benchmark measure life) annually, with the four annual values then summed to determine whether the 4-year goal was met.

[26] Note that the time periods, savings levels and measure lives used in this example are not recommended values for any of those parameters. They are used for illustrative purposes only.

APPLICABILITY OF SAVINGS GOALS TO SMALL UTILITIES

Analysis of small utilities' efficiency program savings goals and performance data suggests that savings targets similar to those of large utilities are achievable. With a savings goal of 1% of sales in 2012 (following a 3 year ramp-up period), the average percent of this goal achieved by the 57 small electric utilities was 111%. The 4 small gas utilities achieved an average of 153% of a 0.75% four year savings target.

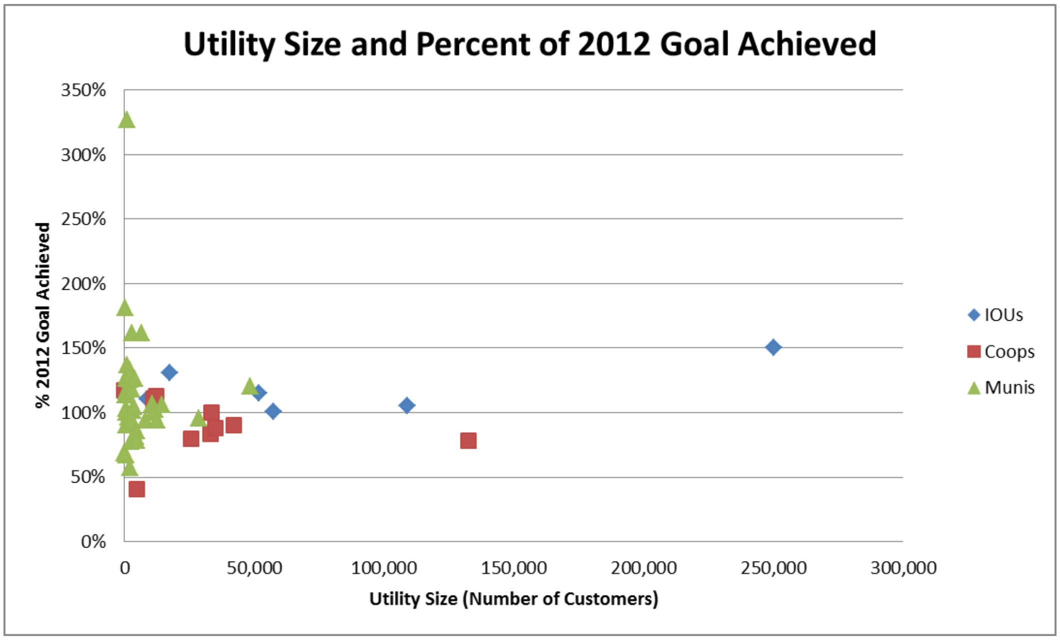
VARIATION IN GOAL ACHIEVEMENT

Savings performance does vary by type of small utilities (IOU, Coop, Muni) as well as the utilities' participation in Efficiency United (EU). While the average achievement of electric IOUs and Munis was well above 100 percent (119 and 115% respectively), the average achievement for Co-ops was 90%. Overall, the utilities that are part of Efficiency United achieved greater savings than the non-EU utilities (122 and 105 percent respectively). While the percent of goal achievement was widely spread and ranged from 40 to 327% for non-EU utilities, every EU utility met over 100% of the savings target with a range of 102 to 182%. The success of small utilities that are members of EU suggests that those underachieving utilities may be able to reach goals by participating in Efficiency United. By choosing not to join EU, utilities should be confident that they can achieve goals on their own choose not to join EU this should be because they are confident that they can achieve goals on their own.

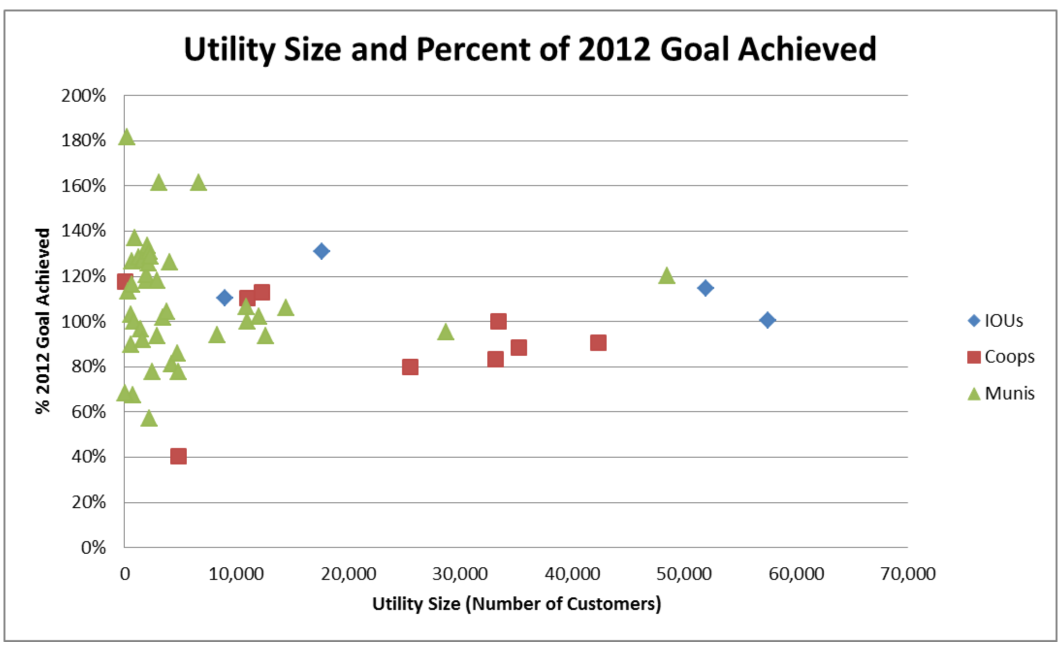
GOAL ACHIEVEMENT AS A FUNCTION OF UTILITY SIZE

Data on the number of customers was only available for electric IOUs and Coops. Rough estimates of utility size for Michigan's Munis were estimate based on the number of households reported in U.S. Census data from 2010.[27] Analysis of the data suggests that utility size does not appear to be a primary driver of performance outcomes. The average percent of the target achieved for the smallest half of utilities is 98% while the larger half achieved an average of 104%; however, it is likely that those utilities that did not meet goals were randomly distributed rather than related to utility size. For example, both the largest and the smallest utility achieved well over 100% of the savings goal (151 and 118%). Yet, the achievement percentage of the two median sized utilities came to an average of 92 percent. As demonstrated by the table below, a linear relationship between utility size and goal achievement is difficult to discern.

[27] For Detroit DPL, the customer estimate of 115 was taken from a Detroit News article. Nichols, Darren A., "DTE to Take Over Detroit Electricity Service." *The Detroit News.* June 27, 2013.



Removing the three largest utilities and the utility that achieved over 300% of its saving goal provides an even clearer picture of the lack of relationship between utility size and goal achievement.



Although the data analyzed suggests that small utilities are meeting their performance goals, we have not obtained data sufficient to scrutinize the source of the savings in terms of individual programs and measures. It is possible that some utilities have been effectively cream skimming (e.g., achieving savings mostly from CFLs) and that achieve goals while offering more comprehensive programs might be a greater challenge. We hope to be able to obtain and analyze this data and include discussion of results in a final report. However, we believe the goals overall are not so aggressive that we are overly concerned about this issue or about small utilities running out of low hanging fruit any time soon.

SMALL UTILITY PERFORMANCE BEYOND MICHIGAN

Performance outcomes from communities participating in Efficiency Smart largely corroborate the results in Michigan described above. Efficiency Smart is a program of energy efficiency services offered to 49 municipal electric providers, primarily in Ohio, that are members of American Municipal Power, Inc. (AMP). In 2012, the second year of Efficiency Smart's operation, the program achieved more than 140% of its performance target for that year and almost 75% of its three-year energy savings goal.[28] In 2012, Efficiency Smart achieved more than 140 percent of its performance target. The three-year service period, beginning in 2011, was designed to save participants 81,000 megawatt-hours (MWh) of energy by the end of 2013.[29] Efficiency Smart exceeded this level of savings in March, and has turned its attention to individual savings targets for each of its participating municipalities. As of July 15, 2013, 34 participating communities had achieved at least 70% of their energy savings goal, with 22 of those municipalities already surpassing 100% of their savings target.[30]

CONCLUSION

Analysis of savings goals and achievements of small utilities in Michigan suggests that statewide savings goals are appropriate and attainable. On average, Michigan's small utilities met over 100% of the savings goal of 1% of retail sales in 2012. Additionally, all individual utilities participating in Efficiency United met over 100 percent of savings targets. Those utilities that are struggling to meet statewide goals have the option of participating in Efficiency United as a way to improve performance. Therefore, we recommend that the MPSC hold the state's small utilities to the same saving goals and standards as those developed for larger IOUs. A forthcoming analysis for the Michigan PSC will analyze whether goals post 2015 should be increased, decreased, or held the same, and whether the structure of the targets should be changed (such as the use of lifecycle energy targets or the addition of peak demand targets). If ultimately there is a decision to increase current goals substantially, we will review whether these higher goals are still achievable by the smallest utilities. However, at this stage we believe the current goals are sufficiently achievable by all utilities regardless of size.

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[28] Efficiency Smart, "2012 Annual Report—Energizing the Future." Accessed July 29, 2013. http://www.efficiencysmart.org/Media/Documents/Publications/2012%20Efficiency%20Smart%20Annual%20Report.pdf.

[29] AMP's Newsroom, "AMP/VEIC Execute New Efficiency Smart Contract." July 15, 2013. http://amppartners.org/newsroom/amp-veic-execute-efficiency-smart-contract/.

[30] Ibid.

Appendix D: Energy Efficiency Cost-Effectiveness Tests

Initial Draft Prepared by Synapse Energy Economics

Introduction

The Office of the Governor and his designees are developing a report for Michigan citizens and policymakers that factually describes and summarizes energy optimization programs set forth in Public Act 295 of 2008. Synapse Energy Economics, Inc. (Synapse) has been hired by the Council of Michigan Foundations (CMF) to draft this report focusing on cost-effectiveness tests used for evaluating the economics of energy efficiency and demand response programs.

Cost-Effectiveness Tests Section of Energy Efficiency Policy Report

1. Introduction

This section of the energy efficiency policy summary report addresses current issues with cost-effectiveness screening practices. It summarizes and compares the current energy efficiency cost-effectiveness policies and practices in Michigan and other jurisdictions.

Subsection 2 provides an overview of the general practices and methodologies used for energy efficiency screening in the US. This provides an important foundation for understanding the practices used across states. Appendix B discusses best practices for select, relevant issues in cost-effectiveness screening practices. Subsection 2 also defines the cost-effectiveness screening practices that were surveyed and reviewed in Michigan and other jurisdictions.

Subsection 3 describes Michigan's energy efficiency cost-effectiveness screening policies and practices in detail, including a summary of Act 295's policy goals.

Subsection 4 provides the results of our survey on cost-effectiveness testing policies and practices conducted for the following states: Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin. This subsection includes a table summarizing the results of the survey, indicating the current cost-effectiveness tests, primary policies, and key assumptions used across the states (see Table 2). It also includes a description of the policy contexts in each state that have resulted in the specific practices used by that state, based upon interviews with commission staff and reviews of relevant legislation and commission orders. This policy context provides useful information regarding the reasons why each state has chosen its specific screening practices.

Subsection 5 compares Michigan's current cost-effectiveness screening practices with the practices used in other states. It summarizes key findings from the state surveys and research, and discusses the advantages and disadvantages of certain screening practices. This subsection also discusses how Michigan's cost-effectiveness tests are meeting the current and any possible future state public policy goals in comparison to other states' practices.

2. Cost-Effectiveness Tests Fundamentals

2.1 Background on the Evolution of Energy Efficiency Programs and the Increasing Importance of Screening for Cost-Effectiveness

Since the inception of ratepayer-funded energy efficiency programs, cost-effectiveness screening practices have been employed to ensure that the use of ratepayer funds results in sufficient benefits. Screening practices have allowed regulators to promote investments in energy efficiency resources that benefit customers, utility systems, and society. In general, historical energy efficiency programs have proven successful with strong cost-effective results, leading to additional investment in energy efficiency resources.

Increasingly, energy efficiency resources are viewed as a means to curb expensive power supply, mitigate the need for increasing transmission and distribution (T&D) investments, and reduce environmental impacts, particularly with regard to climate change. Consequently, many states have adopted increasingly aggressive energy efficiency standards, or requirements that program administrators procure all available cost-effective energy efficiency.

In response, energy efficiency programs are evolving in order to meet increasingly aggressive savings goals. For example, a growing number of program administrators are implementing more comprehensive programs (e.g., whole house retrofits) that may incur higher up-front costs than other more traditional energy efficiency programs (e.g., lighting), but that produce larger, longer-term benefits. Some administrators are also implementing programs for traditionally underserved market segments such as multi-family residents and small businesses. These developments in efficiency goals and efficiency program designs warrant increased scrutiny of the practices and methodologies used to screen energy efficiency for cost-effectiveness.

2.2 Overview of the Tests Used for Efficiency Screening

There are three tests used most often across the country to determine the cost-effectiveness of energy efficiency programs: the Program Administrator Cost (PAC)[1] test, the Total Resource Cost (TRC) test, and the Societal Cost test. Each of these tests combines the various costs and benefits of energy efficiency programs in different ways, depending upon which costs and which benefits pertain to different parties. The costs and benefits of these tests are summarized in Table 1, below.

Table 1: Components of the Energy Efficiency Cost-Effectiveness Tests

	PAC Test	TRC Test	Societal Cost Test
Energy Efficiency Program Benefits:			
Avoided Energy Costs	Yes	Yes	Yes
Avoided Capacity Costs	Yes	Yes	Yes

[1] The Program Administrator Cost test is also called the Utility System Resource Cost Test (USRCT) as referred to in Michigan Public Act 295.

Avoided Transmission and Distribution Costs	Yes	Yes	Yes
Wholesale Market Price Suppression Effects	Yes	Yes	Yes
Avoided Cost of Environmental Compliance	Yes	Yes	Yes
Reduced Risk	Yes	Yes	Yes
Other Resource Savings (e.g., water, oil, gas)	---	Yes	Yes
Non-Energy Benefits (utility-perspective)	Yes	Yes	Yes
Non-Energy Benefits (participant-perspective)	---	Yes	Yes
Non-Energy Benefits (societal-perspective)	---	---	Yes
Energy Efficiency Program Costs:			
Program Administrator Costs	Yes	Yes	Yes
EE Measure Cost: Program Financial Incentive	Yes	Yes	Yes
EE Measure Cost: Participant Contribution	---	Yes	Yes

It is important to recognize that the different tests provide different types of information. Each test is designed to estimate the costs and benefits of efficiency investments from different perspectives. While all of these different perspectives may be considered relevant and important, and warrant consideration, states typically use one of these tests as the primary test to determine whether to invest ratepayer funds in energy efficiency programs.

- The Societal Cost test includes all impacts to all members of society.[2] It includes all the costs and benefits of the TRC test, but also includes societal impacts. These impacts typically fall within the following categories: environmental impacts; reduced health care costs; economic development impacts; reduced tax burdens; and national security impacts.
- The TRC test includes all the costs and benefits to the program administrator and the program participants. It includes all of the costs and benefits of the PAC test, but also includes participant costs and participant benefits. It offers the advantage of including the full incremental cost of the efficiency measure, regardless of which portion of that cost is paid for by the utility and which portion is paid for by the participating customer.
- The PAC test includes all of the costs and benefits experienced by the utility. It includes all the costs incurred by the utility to implement efficiency programs, and all the benefits associated with avoided generation, transmission and distribution costs. This test is limited to the impacts that would eventually be charged to all customers through the revenue requirements; the costs being those costs passed on to ratepayers for implementing the efficiency programs, and the benefits being the supply-side costs that are avoided and not passed on to ratepayers as a result of the efficiency programs. This test provides an indication of the extent to which utility costs, and therefore average customer bills, will be reduced by energy efficiency.

[2] The Societal Cost test can be defined using different boundaries, e.g., the societal impacts within the state, the country, or the world. Since greenhouse gas emissions from the electricity industry have global impacts, the Societal Cost test should include global costs and benefits.

Ever since ratepayer-funded energy efficiency programs have been in place, there has been considerable debate about which test is best to use for screening energy efficiency. However, it should be noted that – while the choice of test is important – it is even more important to ensure that each test is properly applied. This means they are applied in a way that: achieves its underlying objectives; is internally consistent; accounts for the full value of energy efficiency resources; and uses appropriate planning methodologies and assumptions.

2.3 Accounting for Other Program Impacts

One of the more challenging aspects of applying cost-effectiveness tests is properly accounting for "other program impacts" (OPIs). This term is used to describe two important types of impacts of energy efficiency programs. First, it includes non-energy benefits (NEBs), which includes those benefits that are not part of the costs, or the avoided costs, of the energy efficiency provided by the utility. Second, OPIs also include "other fuel savings," which are the savings of fuels that are not provided by the utility that funds the efficiency program. (Synapse 2012b).

There is a wide range of OPIs associated with energy efficiency programs. OPIs are categorized by the perspective of the party that experiences the impact: the utility, the participant, or society at large:

- Utility-perspective OPIs include financial benefits to the utility from reducing customer bills, including for example, reduced arrearages and bad debt, and improved customer services.
- Participant-perspective OPIs include a variety of NEBs to the program participants, including for example, reduced operation and maintenance (O&M) costs, improved comfort, improved health and safety, increased worker and student productivity, and utility-related benefits (e.g., reduced termination and reconnection). Some of these NEBs can be particularly significant for low-income program participants. Participant perspective OPIs also include reduced water use and other fuel savings.
- Societal-perspective OPIs include those non-energy benefits that accrue to society, including for example, environmental benefits, reduced health care costs, economic development impacts, reduced tax burdens, and national security impacts.

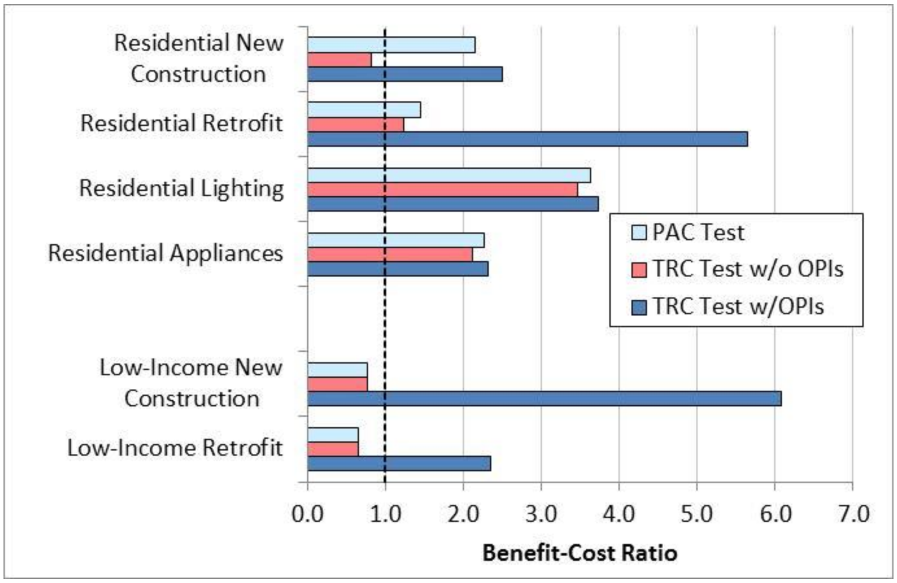
OPIs should technically be included in cost-effectiveness tests for which the relevant costs and benefits are applicable:

- When using the Societal Cost test, the utility-perspective, participant-perspective, and societal-perspective OPIs should be included.
- When using the TRC test, the utility-perspective and participant-perspective OPIs should be included to the greatest extent possible.
- When using the PAC test, the utility-perspective OPIs should be included to the greatest extent possible.

If any one test includes some of the costs (or benefits) from one perspective, but excludes some of the costs (or benefits) from that same perspective, then the test results will be skewed, i.e., they will not provide an accurate indication of cost-effectiveness from that perspective. This concern has been particularly problematic with regard to the TRC test. The TRC test includes the impacts to both the utility and the program participant, and therefore should account for all of the costs and all the benefits that are experienced by the utility and the participants. This requires including all of the participant-perspective OPIs. (Synapse 2012b; Neme and Kushler 2010).

The importance of adequately accounting for OPIs is apparent in many program administrators' energy efficiency screening results. Figure 1 presents the planned cost-effectiveness results for an electric utility in Massachusetts for energy efficiency programs planned for implementation in 2012. The figure presents the benefit-cost ratios under the PAC test, the TRC test with OPIs included, and the TRC test without OPIs included.

Figure 1: Cost-Effectiveness Analysis Implications of OPIs; PAC and TRC Tests



Source: Synapse 2012a.

Note that if the OPIs are not included in the TRC test, then the low-income, residential new construction and residential retrofit programs are all at risk of being inaccurately deemed not cost-effective. These energy efficiency programs are especially important because they help to support more comprehensive efficiency services to a more diverse set of residential customers, which promotes greater customer equity, both within the residential sector and between the residential and other sectors. Promoting customer equity is an important objective underlying the energy efficiency programs.

2.4 Attributes Surveyed in Each Jurisdiction

We researched the cost-effectiveness screening practices in eight states, in addition to Michigan. As mentioned above, the eight surveyed states include Connecticut, Illinois, Massachusetts, Minnesota, New York, Oregon, Vermont, and Wisconsin. For each state, we researched three primary attributes regarding cost-effectiveness screening: cost-effectiveness test(s) and their application, the avoided costs included in the primary cost-effectiveness test, and the OPIs included in the primary cost-effectiveness test. The specific attributes we identified for each state are defined and discussed below.

Cost-Effectiveness Test(s) and Methodologies

- *Primary test*: the primary test, as identified in Section 2.2 above, the state relies on to screen for cost-effectiveness.
- *Secondary test*: the secondary tests or combination of tests that the state uses to inform the cost-effectiveness review process, as applicable.
- *Screening level*: the level at which the primary test is applied to determine cost-effectiveness: either the portfolio, program, project, or measure level. In some instances, a state may screen for cost-effectiveness at multiple levels to inform the review process.
- *Discount rate*: an interest rate applied to a stream of future costs and/or monetized benefits to convert those values to a common period, typically the current or near-term year, to reflect the time value of money. (NEEP 2011, p 15).
- *Study period*: the length of time over which benefits from energy efficiency measures are included in benefit-cost analysis. The study period typically corresponds to measures that have the longest measure life, but not always.[3]

Avoided Costs Included in the Primary Cost-Effectiveness Test

- *Definition of Avoided Costs*: In the context of energy efficiency, avoided costs are the costs that are avoided by the implementation of an energy efficiency measure, program, or practice. Such costs are used in benefit-cost analyses of energy efficiency measures and programs. Because efficiency activity reduces the need for electric generation, these costs include those associated with the cost of electric generation, transmission, distribution, and reliability. Typically, costs associated with avoided energy and generation capacity are calculated. Other costs avoided by the efficiency activity can also be included, among them the value of avoided emissions not already embedded in the generation cost, impact of the demand reduction on the overall market price for electricity, avoided fuel or water, etc. (NEEP 2011, p 8).
- *Avoided Costs in the Survey*: Our survey specifically reviewed whether the following avoided costs are included in a state's energy efficiency benefit-cost analyses: capacity costs, energy costs, transmission and distribution (T&D) costs, environmental compliance costs, price suppression, reduced line losses, reduced risk, and any other avoided costs. Other avoided costs were not specifically defined; rather this category provided an opportunity to account for state-specific avoided costs that may not be captured in the previous avoided costs.
- *Avoided Cost of Environmental Compliance*: It is now common practice to include the cost of complying with some environmental regulations within the costs avoided by energy efficiency resources (e.g., the cost of purchasing SO_2 and NO_X allowances and the cost of purchasing CO_2 allowances to comply with the Regional Greenhouse Gas Initiative).[4] However, it is less common to fully account for the costs of complying with forthcoming or anticipated environmental regulations, particularly regulations related to climate change. The costs of environmental

[3] Note that measure life as used in Table 2, below, implies that the study period is determined by the measures with the longest measure lives. The actual measure lives for measures with useful lives shorter than the longest measure life are used in benefit-cost analyses.

[4] Michigan does not purchase CO_2 allowances, nor is there any requirement for Michigan to purchase CO_2 allowances at this time.

compliance will eventually be borne by the utility and passed on to ratepayers, and therefore should be included in the PAC, the TRC and the Societal Cost tests. These costs are different from environmental externalities, which include only the environmental costs that occur after all environmental regulations have been met. (Synapse 2012b.)

- *Price Suppression Effect*: In regions of the country with organized wholesale energy and capacity markets, reduced energy and capacity demands from energy efficiency savings lead to reduced wholesale energy and capacity prices. Because wholesale energy and capacity markets provide a single clearing price to all wholesale suppliers, and therefore all customers purchasing power in the relevant time period, the reductions in wholesale energy and capacity clearing prices represent a benefit experienced by all customers of those markets. Over time, price suppression benefits dissipate as market participants respond to the lower clearing price, thereby shifting the supply curve and causing prices to rise back towards initial market prices.[5]
- *Reduced Risk*: Energy efficiency can mitigate the various risks associated with conventional power plants, including risks associated with fuel prices, construction costs, planning, reliability, new regulations, wholesale market operations, T&D constraints, and water constraints. Risk mitigation benefits of energy efficiency resources can be recognized either through system modeling when calculating avoided costs; through risk adjustments to the energy efficiency benefits; or through risk adjustments to the discount rate used in the cost-effectiveness analysis. Risk mitigation benefits will eventually impact utility costs and be passed on to ratepayers, therefore they should be included in the PAC, the TRC and the Societal Cost tests. (Synapse 2012a.)

Other Program Impacts Included in the Primary Cost-Effectiveness Test

- *Other Program Impacts*. The survey identified whether each state accounts for OPIs in the primary cost-effectiveness tests. For each category of OPIs, we also identified how the OPIs are accounted for (i.e., whether OPIs are quantified directly, accounted for through an adder, or considered qualitatively).
- *Utility-Perspective OPIs*: Utility-perspective OPIs are indirect costs or savings to the utility, and eventually its ratepayers. Such OPIs include benefits and costs associated with arrearages and bad debt, and improved customer service.
- *Participant-Perspective OPIs*: Participants in both low-income and non-low-income programs can realize a variety of OPIs from energy efficiency programs. The specific categories of OPIs that were surveyed are: resource savings, low-income benefits, equipment and operation and maintenance benefits, improved comfort, increased health and safety, increased property value, and utility-related benefits. While this categorization could be further divided, we found this breakout appropriate for the survey's purposes.
- *Societal-Perspective OPIs:* Societal-Perspective OPIs are indirect program effects beyond those realized by utilities, their ratepayers, or program participants, but accrue to society at large. Such OPIs include benefits and costs associated with environmental impacts, economic development, national security, and healthcare.

[5] In the New England Avoided Energy Supply Costs study (AESC), the forecast of price suppression effects accounts for this dissipation (Synapse 2013a, p 7-2).

We will also provide each state's 2012 ACEEE Scorecard ranking, which is intended to indicate the comprehensiveness and aggressiveness of each state's historical energy efficiency programs. The ACEEE Scorecard ranks states on their policy and program efforts, documents best practices, and provides recommendations for ways in which states can improve their energy efficiency performance. The scorecard serves as a benchmark for state efforts on energy efficiency policies and programs each year, encouraging them to continue strengthening efficiency commitments. The 2012 ACEEE Scorecard is the sixth edition of this report, with the 2013 ACEEE Scorecard expected to be released in October 2013. (ACEEE 2012b, p v).

3. Michigan's Cost-Effectiveness Tests

Approved on October 6, 2008, Public Act 295 of 2008, also known as the Clean, Renewable, and Efficient Energy Act, is Michigan's premier legislation on Demand-Side Management (DSM) programs. Prior to Act 295, energy efficiency programs had not been in operation in Michigan since 1992, and even then were limited in scope. Therefore, much of Michigan's current energy efficiency cost-effectiveness policies and practices stem from the goal of simply getting the programs quickly, but efficiently designed and implemented to comply with Act 295.

The purpose of Act 295 is clearly stated as "to promote the development of clean energy, renewable energy, and energy optimization through the implementation of a clean, renewable, and energy efficient standard that will cost-effectively do all of the following: (a) diversify the resources used to reliably meet the energy needs of consumers in this state; (b) provide greater energy security through the use of indigenous energy resources available within the state; (c) encourage private investment in renewable energy and energy efficiency; and(d) provide improved air quality and other benefits to energy consumers and citizens of this state." (Act 295, §1). Specifically for energy optimization, the overall goal is to "reduce the future costs of provider service to customer," meaning to reduce the cost of electricity services to customers (Act 295, §71).

Because Act 295's goal for energy optimization focuses on the cost of utility service, the act requires the use of the Program Administrator Cost test, also called the Utility System Resource Cost test. Through subsequent orders and approval of energy optimization plans, the Michigan Public Service Commission (MI PSC) has further detailed the state's cost-effectiveness screening practices. Specifically, the MI PSC requires that the program administrators provide the results of multiple cost-effectiveness tests, including the TRC test, the RIM test, and the Participant Cost test, in order to provide the MI PSC with sufficient information to support the distribution of energy optimization funds among the portfolio of proposed programs, and to ensure that the programs are reasonable and prudent Act 295 requires that the portfolio of programs collectively demonstrate cost-effectiveness under the PAC test, excluding program offerings to low-income residential customers. (Act 295, §71(3)(g); §73(2)). The MI PSC has also required that the utilities provide the results of cost-effectiveness tests at the program and measure levels, again to ensure equitable distribution of energy optimization funds among the proposed programs.

To date, the savings goals for Michigan utilities have been relatively low, and the absence of energy efficiency programs since 1992 provided program administrators with significant energy efficiency savings potential. Therefore, the programs have had little difficultly demonstrating cost-effectiveness at the portfolio, program, or measure levels for any of the cost-effectiveness tests. With three full years of program implementation completed, cost-effectiveness results may begin to be challenged. The MI PSC has allowed program administrators to determine the discount rate used to net present value the future stream of energy efficiency benefits. The program administrators have chosen to rely on the weighted average cost of capital to discount benefits, which has typically been around 8%. The Consumers Energy uniform discount rate in its 2011 energy efficiency annual report was 9.78%. (Consumers Energy 2012, p 18). The deemed savings database used in Michigan previously capped measure lives at 20 years. The cap was lifted with the 2013 version of the deemed savings database to allow for the full lifetime of the measures installed, thereby setting the study period over which the cost-effectiveness tests are applied. Michigan's energy efficiency collaborative has been investigating ways to remove such structural biases against energy efficiency programs by encouraging more permanent energy efficiency measures with longer measure lives.

The MI PSC has specified that the PAC test analysis take "into account the avoided supply costs of energy and demand, the reduction in transmission, distribution, generation, future carbon tax, and capacity valued at marginal costs for the periods when there is a load reduction… At the option of the provider, either the cost-based value provided by the commission or the MISO market-based value can be used as a determinant in estimating the avoided cost." (MI PSC 2008, Att. E, pp 4-5). Michigan also accounts for avoided costs associated with line losses. The avoided supply costs of future carbon tax has been included for renewable energy programs only, and has not been included in cost-effectiveness testing for energy efficiency programs. While the MI PSC allows for the inclusion of avoided costs associated with future environmental compliance regulations, the Michigan utilities currently do not include such benefits in their cost-effectiveness analyses. The avoided transmission and distribution costs included in energy efficiency cost-effectiveness analysis are specific to each utility and could be relatively low. For example, Consumers Energy has noted that the current utility system structure would need to change substantially before the cost of building new transmission and distribution could be avoided. In its 2011 benefit cost analysis, the company used a $5 per kW T&D avoided cost value, with essentially reflects reduce maintenance costs. (Consumers Energy 2012, p 19;).

Benefits associated with price suppression and reduced risk have not been included in cost-effectiveness screening, nor addressed by the MI PSC. Act 295 acknowledges the other program impacts that accrue to low-income customers by excluding low-income programs from cost-effectiveness requirements (Act 295, §71(3)(g)). Additionally, natural gas savings are accounted for only in the natural gas programs. The MI PSC has not required the inclusion of any other non-energy benefits in energy efficiency cost-effectiveness screenings because it relies on the PAC test, which does not consider such impacts on participants. While utility-perspective other program impacts could be included as part of the PAC test results, the MI PSC has not addressed them to date.

4. Other Jurisdiction's Cost-Effectiveness Tests

4.1 Summary of Survey Results

In addition to Michigan, we researched the cost-effectiveness screening practices in eight states across the United States. The results of the state surveys are summarized in Table 2. We provide additional detail for each state in the tables in Appendix A.

To provide context for each state's energy efficiency practices, we conducted interviews with state public utility commission staff. The goal of these interviews was for commission staff to provide the anecdotal background on how its state developed the energy efficiency screening policies and practices currently in place, focusing on areas where states differ from each other. The interviews also aim to capture the bigger picture policy context that influences energy efficiency screening policy decisions and practices within each state. Each state's section, below, provides a historical overview of the state's energy efficiency cost-effectiveness policy, followed by a summary of a few specific aspects of the state's screening practices. The few specific aspects we focus on are intended to highlight practices that differ across states or explain why certain benefits are omitted by a state.

To summarize, our survey indicates that:

1. All of the states we surveyed provide relatively comprehensive energy efficiency programs according to ACEEE, as they are all ranked within the top 20 most energy efficient states.
2. Cost-effectiveness practices are largely driven by key policy objectives specific to each state. We summarize these objectives in the second row of Table 2.
3. Most states screen for cost-effectiveness using the TRC as the primary test, while a few states rely on the Societal Cost test or the PAC test as the primary test.
4. Most states determine cost-effectiveness at either the portfolio or program level, with one state screening at the measure level and one state screening at the sector level. Most states consider results from additional screening levels in addition to the primary screening level.
5. Several different discount rates are used across the states, although the utility weighted average cost of capital is most frequently used by the states. Other states use low-risk or societal discount rates. We note that different discount rates can have significant impacts on the results of the cost-effectiveness screening.
6. All but one state apply a study period that includes the full useful life of the measures.
7. All states account for avoided costs of energy, capacity, and complying with environmental regulations. However, we did not investigate the extent to which the methodologies, assumptions and results are appropriate or consistent across the states.
8. All but one state account for avoided costs and transmission and distribution.
9. Most states do not account for price suppression effects, with only two states including such benefits.
10. Most states do not account for risk mitigation benefits, with only two states include such benefits.

11. All but one state that uses the TRC test or the Societal Cost test account for the participant-perspective resource benefits: water savings, oil savings, gas savings (for electric utilities), and electric savings (for gas utilities).
12. All but one state at least qualitatively account for the participant-perspective low-income benefits, typically by not requiring that low-income programs or measures pass the state's cost-effectiveness test.
13. States treat the participant-perspective non-energy benefits very differently:
    - One state uses quantified values for non-energy benefits.
    - Two states use adders to represent non-energy benefits.
    - Several states include few or no non-energy benefits, despite using the TRC test or Societal Cost test as the primary test.

Table 2: State Cost-Effectiveness Summary

Cost-Effectiveness Metric		Michigan	Connecticut	Illinois	Massachusetts	Minnesota	New York	Oregon	Vermont	Wisconsin
2012 ACEEE Scorecard Ranking		12	6	14	1	9	3	4	5	17
Primary Policy Driver		Reduce the cost of utility service	Focus on electric system impacts only	Diverse program offerings to customers	All available cost-effective energy efficiency	Achieve annual savings goal of 1.5% of sales	Maximize cost-effectiveness given limited funding	All-Cost Effective Measures	Least cost planning including environmental costs	All cost-effectiveness energy efficiency up to funding cap
Cost-Effectiveness Test(s) & Application	Primary Test	PAC	PAC	TRC	TRC	Societal	TRC	TRC	Societal	TRC
	Secondary Test	TRC, RIM, Participant	TRC	n/a	n/a	PAC, Participant, TRC, RIM	n/a	PAC	TRB; PAC	PAC; Expanded TRC
	Primary Screening Level	Portfolio	Program	Portfolio or Program	Program	Segment (essentially Sector)	Measure	Program	Portfolio	Portfolio
	Additional Screening Level(s)	Program, Measure	n/a	Portfolio, Program, Measure	n/a	Portfolio, Program, Measure	Project, Program	Measure	Program, Project, Measure	Measure, Program
	Discount rate used in Test	Utility WACC (Ranges: 7%-10%)	Utility WACC (currently 7.43%)	WACC (currently 3.93%)	Low-Risk 10Yr Treasury (currently 0.55%)	Social Discount Rate (currently 2.67%) WACC (7.04% for Xcel)	Utility WACC (currently 5.5%)	Utility WACC (Currently 5.2%)	Societal (currently 3%)	Low-Risk (currently 2%)
	Study period over which Test is applied	Measure Life	Measure Life	Measure Life	Measure Life	15 years	Measure Life	Measure Life	Measure Life	Measure Life
Avoided Costs Included in Primary Cost-Effectiveness Test	Capacity Costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Energy Costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	T&D Costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	Environmental Compliance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Price Suppression	No	Yes	No	Yes	No	No	No	No	No
	Line Loss Costs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Reduced Risk	No	No	No	No	No	No	Yes	Yes	No
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Utility OPIs	No	No	No	Quantified	No	No	Part of 10% Adder	Part of 15% Adder	No
	Participant OPIs									
	Resource	No	No	Quantified	Quantified	No	Quantified	Part of 10% Adder	Quantified	Quantified
	Low-Income	Qualitative	Qualitative	Qualitative	Quantified	Qualitative	Qualitative	Part of 10% Adder	Additional 15% Adder	No
	Equipment	No	No	No	Quantified	No	Qualitative	Part of 10% Adder	O&M Quantified	No
	Comfort	No	No	No	Quantified	No	No	Part of 10% Adder	Part of 15% Adder	No
	Health & Safety	No	No	No	Quantified	No	No	Part of 10% Adder	Part of 15% Adder	No
	Property Value	No	No	No	Quantified	No	No	Part of 10% Adder	Part of 15% Adder	No
	Utility Related	No	No	No	Quantified	No	No	Part of 10% Adder	Part of 15% Adder	No
	Societal OPIs	No	No	No	No	No	No	No	Part of 15% Adder	No

4.2 Connecticut

The Program Administrator Cost test[6] has been the primary cost-effectiveness test in Connecticut for many years. As far back as 1998, the Connecticut Department of Public Utility Control (CT DPUC)[7] stated that it "has repeatedly endorsed the utility cost test as the preferred method to evaluating conservation programs. Its logic is sound, its priorities are straightforward, and it will result in more conservation for lower cost to electric customers" (CT DPUC 1999, pp 18-20). Specifically to this last point, the CT DPUC has relied on the PAC test due to the test's focus on the electric system's cost and benefits, which is the driving energy efficiency policy in the state.

For instance, in 2003, southwestern Connecticut experienced capacity system constraints due to generation comprised of older, inefficient, fossil fueled units, and to strain on the system during periods of peak demand. To help mitigate increases in electricity demand, the CT DPUC stated that it would look much more closely at the value that each energy efficiency program provides. The CT DPUC directed the utilities to undertake efforts to maximize electric savings in all programs. The most cost-effective programs were expanded while those that were less cost-effective were phased out, reduced, or eliminated. (CT DPUC 1999, p 4).

The CT DPUC has also focused on electric system benefits due to the desire to avoid cross-subsidization from electric or gas customers to oil customers. The CT DPUC previously stated that program administrators should "continually strive to reduce inter fuel subsidies and match the funding sources to those receiving the benefits." (Personal Communication with CT DEEP Staff; CT PUC 2011, p 14). Recent legislation may alter the CT DPUC's focus on the electricity system, as the state's statute for assessment of conservation and load management programs now requires that utilities provide programs that offer "similar efficiency measures that save more than one fuel resource or otherwise coordinate programs targeted at saving more than one fuel resource." CT G.L. 16-245m (d)(1), (d)(5).

The CT DPUC has addressed risk associated with energy efficiency programs in the context of discount rates. The CT DPUC stated that a 5% discount rate is extremely low because conservation is not a risk free investment. The CT DPUC directed that the discount rate be no lower than 7% for benefit-cost analysis to reflect the risk associated with energy efficiency programs. (CT DPUC 2010, p 59). Connecticut does not associate risk benefits with energy efficiency investments, and therefore does not include such benefits in cost-effectiveness testing (Personal Communication with CT DEEP Staff).

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[6] The PAC test or Utility Cost test is referred to as the Electric System test in Connecticut.

[7] The Connecticut Department of Energy and Environmental Protection (DEEP) was established on July 1, 2011 with the consolidation of the Department of Environmental Protection, the Department of Public Utility Control, and energy policy staff from other areas of state government. The Public Utilities Regulatory Authority (PURA) replaces the former Department of Public Utility Control along with the Bureau of Energy and Technology Policy. PURA is part of the Energy Branch of DEEP, and is statutorily charged with regulating the rates and services of Connecticut's investor owned electricity, natural gas, water and telecommunication companies and is the franchising authority for the state's cable television companies. (DEEP 2013; PURA 2013).

Other program impacts have been addressed by the CT DPUC on a limited basis in that it has repeatedly approved non-cost-effective low-income programs. For example, in 1999, the CT DPUC recognized "the benefits of energy conservation to low-income customers, such as a reduction in hardship customers and a reduction in uncollectible bills, which are not included in the benefit/cost ratios" (CT DPUC 1999, p 3). More recently, the CT DPUC stated that it continues to believe there are significant opportunities to improve energy efficiency for low-income customers, despite the fact that the low-income program is an all fuels program whereby electric customers subsidize oil measures (CT DPUC 2010, p 15).

4.3 Illinois

The Illinois Public Utilities Act requires the state of Illinois to balance achievement of a number of policy goals, stating that "electric utilities are required to use cost-effective energy efficiency and demand-response measures to reduce delivery load. Requiring investment in cost-effective energy efficiency and demand-response measures will reduce direct and indirect costs to consumers by decreasing environmental impacts and by avoiding or delaying the need for new generation, transmission, and distribution infrastructure." (220 ILCS 5/8-103, § 8-103(a)). The act further states that utilities shall demonstrate that its overall portfolio of energy efficiency and demand-response measures are cost-effective using the total resource cost test and represent a diverse cross-section of opportunities for customers of all rate classes to participate in the programs. (220 ILCS 5/8-103, § 8-103(f)(5)). As such, Illinois relies on the TRC test to screen for cost-effectiveness as it takes into account both the direct and indirect costs to consumers and the utility infrastructure.

Illinois operates two types of energy efficiency programs: those programs that are consistent with 220 ILCS 5/8-103, § 8-103 ("Section 8-103 programs"), and those programs that are consistent with 220 ILCS 5/16-111.5B ("IPA programs").[8] The level at which cost-effectiveness is determined depends on the type of program in consideration. Section 8-103 energy efficiency resources are required to pass the TRC test at the portfolio level, while IPA energy efficiency resources are required to pass the TRC test at the program level.

While the portfolio and program levels are specified in the Illinois Public Utilities Act, the ICC has allowed program administrator discretion on this cost-effectiveness screening practice. Specifically in its approval of Ameren Illinois' energy efficiency plan filings, the ICC stated that "evaluating cost-effectiveness on a portfolio level is necessary to ensure that Ameren not be penalized for planning assumptions that turn out to be inaccurate. The Commission concludes it is appropriate to apply the TRC

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[8] The two types of programs have different goals and delivery structures. The programs are still the subject of stakeholder working groups, which are working through ways to integrate the types of programs. (Personal Communication with ICC Staff; ICC 2013). It should be noted that one utility, MidAmerican Energy Company, offers energy efficiency programs in Illinois pursuant to Section 8-408 of the Illinois Public Utilities Act. (220 ILCS 5/8-408). Section 8-408 applies to small (i.e., fewer than 200,000 customers) multi-jurisdictional utilities, and requires each program to be cost-effective, with the exception of reasonable low-income programs. (220 ILCS 5/8-408, § 8-408(a)). The ICC has required only cost-effective measures in Section 8-408 energy efficiency plans, unless extenuating circumstances are shown that would justify inclusion of such cost-ineffective measures. (ICC 2012a, pp 17-18). MidAmerican uses the Societal Cost test.

test at the portfolio level, but Ameren Illinois should be allowed to apply it at the measure or program level if it so chooses." (ICC 2010a, p 30).

Illinois program administrators account for program benefits over the lifetime of the energy efficiency measures installed, and rely on the weighted average cost of capital to discount the stream of future benefits. (Ameren 2013b, Testimony of Andrew Cottrell, p 10; 20 ILCS 3855/1-10). The weighted average cost of capital is the chosen discount rate because it represents the utility's cost of procuring energy, and therefore parallels energy efficiency resources with alternative supply resources. (Personal Communication with ICC Staff).

In its calculation of avoided costs, Illinois program administrators include the avoided costs of energy, capacity, transmission and distribution, environmental compliance, and line losses. (Ameren 2013b, pp 25-29; Testimony of Andrew Cottrell, pp 9-10). With regard to the avoided costs associated with environmental compliance, the Illinois definition of the TRC test specifically states that, "in calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases." (20 ILCS 3855/1-10).

The ICC has specifically rejected price suppression benefits, finding that the party proposing to include the benefits did not provide adequate basis for deviating from the ICC's past practice of not including such benefits. (ICC 2012b, p 270).

Avoided risk benefits are only included to the extent that they are reflected in MISO or PJM market prices used in avoided energy cost estimates. (Personal Communication with ICC Staff). On a preliminary basis, Ameren considered using a 1.2 TRC test benefit-cost ratio to screen measures to compensate for risk and to ensure that the entire portfolio of programs remained cost-effective with a TRC test benefit-cost ratio of 1.0. However, Ameren did not include such a proposal in its final plan filing with the ICC. (Ameren 2013a, p 22).

Regarding other program impacts, Illinois accounts for benefits to low-income customers by not requiring that such measures meet the TRC test. (220 ILCS 5/8-103, §8-103(a)). For example, the Illinois Department of Commerce and Economic Opportunity's (DCEO) energy efficiency plan submitted in August 2013 states that, "though standards are in place in DCEO's low income programs to assure that products being installed are energy efficient, some of the requirements are primarily for health and safety, comfort and building durability." (DCEO 2013, Testimony of David Baker, p 8).

Further, Illinois legislation stipulates that TRC test benefits include other quantifiable societal benefits, including avoided natural gas utility costs. (20 ILCS 3855/1-10). In practice, this has amounted to program administrators quantifying natural gas and water savings. (Ameren 2013b, pp 24-25). For the first time in their three-year energy efficiency plan filings, the Illinois program administrators are flirting with the idea of accounting for participant OPIs. For example, Ameren initially included a 10% adder in its preliminary energy efficiency plan to account for non-energy benefits (Ameren 2013a, p 22). Similarly, DCEO indicated in its plan filed with the ICC that it is not clear whether non-energy benefits will be included in the TRC calculations, so it provided TRC values both with and without NEBs for certain programs. (DCEO 2013, Testimony of Stefano Galiasso, p 9). The ICC has not yet conducted its review of or issued its decision on the Section 8-103 plans, nor have other program administrators proposed to include such an adder or adjustment in past Section 8-103 plan filings, so it is not yet certain whether or how the ICC will address the inclusion of non-energy benefits. (Personal Communication with ICC Staff).

4.4 Massachusetts

Massachusetts' has been evaluating energy efficiency cost-effectiveness since the late 1980s. However, its fundamental energy efficiency policy was advanced in 1997 with the state's electricity restructuring act, which required the Massachusetts Department of Public Utilities (MA DPU) to ensure that energy efficiency programs are delivered in a cost-effective manner (MA Restructuring Act). In response, the MA DPU opened an investigation to establish the methods and procedures to evaluate and approve energy efficiency programs (MA DTE 1999a). The end result of this investigation was a set of energy efficiency guidelines that address the energy efficiency topics for which the MA DPU has primary responsibility, including energy efficiency program cost-effectiveness (MA DTE 1999b; MA DTE 2000).

In 2008, the An Act Relative to Green Communities (MA GCA) significantly advanced energy efficiency in Massachusetts by requiring that energy efficiency programs capture all available cost-effective efficiency opportunities, which has become the state's driving energy efficiency policy (MA G.L. c 25 § 21(a)). Again in response to the act, the MA DPU opened an investigation to update the previously established energy efficiency guidelines to account for the new legislation (MA DPU 2008). In 2012, the MA DPU again revisited the energy efficiency guidelines to address specific issues associated with energy efficiency program benefits and regulatory filings (MA DPU 2011a; MA DPU 2012).

Risk benefits are not explicitly taken into account in the Massachusetts cost-effectiveness screening, as it has never explicitly been addressed by the MA DPU. However, the MA DPU has acknowledged that energy efficiency resources are a low-risk investment. In both of the MA DPU's investigations following the restructuring act and MA GCA, the MA DPU found that a low-risk discount rate is most appropriate for calculating the present value of the costs and benefits in the TRC test because it reflects the low-risk nature of energy efficiency investments. (MA DPU 2009a, pp 21-23).

Massachusetts explicitly requires that the avoided cost of complying with current and reasonably anticipated future environmental regulations be included in the energy efficiency cost-effectiveness analysis. The DPU also requires that these avoided costs account for the relatively stringent requirements to reduce greenhouse gas emissions required in the Global Warming Solutions Act (GWSA).   (MA DPU 2009a.) However, the DPU has yet to determine a methodology to estimate the value of these avoided costs of environmental compliance (MA DPU 2012). Therefore, these potentially significant benefits are not currently accounted for when screening energy efficiency in Massachusetts.

Massachusetts' energy efficiency guidelines have always required that participant-perspective OPIs be quantified to the extent reasonably possible. The MA DPU specifically rejected the use of an adder to account for participant-specific economic benefits, and instead required that any known, quantifiable, and significant end-use benefits to program participants be included in cost-effectiveness analyses. (MA DTE 1999b, p 14).

4.5 Minnesota

The utilities in Minnesota administer energy efficiency programs through implementation of their three-year Conservation Improvement Program (CIP) plans pursuant to Minnesota Statue 216B.241. This statute requires that each utility achieve an annual energy-savings goal of 1.5% of gross annual retail energy sales. It further requires that the Minnesota Department of Commerce (MN DOC) evaluate the CIP plans on how well the goals were met. (MN Statue 216B.241, subd. 1c.(a)).

Minnesota Statue requires that the Minnesota Department of Commerce, Division of Energy Resources (MN DER) consider the costs and benefits to ratepayers, the utility, participants, and society. (MN Statue 216B.241, subd. 1c.(f)). As such, the investor-owned utilities provide the results of the Societal Cost, PAC, Participant Cost, and RIM tests.[9] (Personal Communication with MN DER Staff). Although the statute requires utilities to provide cost-effectiveness results from all of the stated perspectives, the MN DER focuses on the Societal Cost test for approval purposes, as the Societal Cost test measures the ratio of overall benefits and costs to society of energy conservation improvements (MN DER 2010, p 7).

In April 2012, the MN DER announced a policy for the electric and gas utilities' 2013-2015 CIP plans that cost-effective screening would be primarily evaluated at the segment level, rather than the program level, which was the previous screening level. Segments are generally equivalent to customer sectors, and include business; residential; low-income; renewable energy; and assessments. Existing programs were grandfathered in and allowed to be non-cost-effective, so long as the segment in which they resided in still passed the Societal Cost test. (MN DER 2012, pp 9-10). In addition, the MN DER also reviews cost-effectiveness results at the portfolio and program levels, and sometimes at the measure level. (Personal Communication with MN DER Staff).

Both a societal discount rate and a utility discount rate are used in Minnesota. Since environmental costs are not captured and reflected in market prices, the MN DER has found it necessary to impute and impose a societal discount rate to discount the future stream of benefits resulting from avoided environmental damage. The Minnesota societal discount rate is based on the US Treasury's 20-year constant maturity rate, which was 2.67% as of January 3, 2012. The MN DER Staff found that the US Treasury's 20-year constant maturity rate captures the market's expectations regarding inflation, along with a small risk factor. The MN DER Staff concluded that a rate including inflation expectations and a small risk factor is a reasonable method for estimating a social discount rate for externalities. (MN DER Staff 2012).

The utility discount rate in Minnesota is a utility's weighted cost of capital approved in the utility's most recent rate case. While the weighted cost of capital varies by utility, Xcel Energy's weighted cost of capital was 7.04% in its 2010 rate case. Since the utility discount rate is the utility's cost for its capital, MN DER Staff found it a reasonable measure of the value society places on a utility investment. (MN DER Staff 2012).

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[9] Sometimes the utilities will also provide the results of the TRC test, but it is not required by statute. (Personal Communication with MN DER Staff).

For the Societal Cost test, residential programs use the societal discount rate, and commercial programs use the utility discount rate. The Participant Cost test uses the societal discount rate, and the PAC test uses the utility discount rate. The rationale for such an application is that a societal discount rate would reflect a residential customer's likely opportunity costs (i.e., the return on investment that a residential customer would likely give up in order to invest in CIP). Similarly, the utility discount rate represents an attempt to reflect in a simple manner a reasonable estimate of a business customer's opportunity costs, although the utility discount rate may be lower than the actual discount rate for a particular commercial or industrial customer. (MN DER Staff 2012).

The period over which the cost-effectiveness tests are applied is generally capped at 15 years in Minnesota. The MN DER Staff have stated that, in most cases, the maximum life used is limited to 15 years for the following reasons: (a) benefits are more uncertain the further out in time the model is extended; (b) benefit streams diminish further out in time and have lesser effects on cost-effectiveness than more current years; (c) the further out in time the model is extended, the more uncertain it becomes that current ratepayers, who are funding CIP, receive the full benefits of CIP; and (d) if a project cannot pay for itself within 15 years, ratepayers should instead be funding other, more cost-effective projects. (MN DER Staff 2012; Personal Communication with MN DER Staff).

Electric utilities in Minnesota account for the avoided costs of energy, capacity, T&D, and environmental compliance. While the MN DER provides the inputs for a number of cost-effectiveness screening assumptions, it does not provide electric utility avoided costs as they can vary significantly between utilities. (MN DER 2012, pp 10-11). Line losses are also included in Minnesota's benefit-cost analyses. Typically the utilities will provide line loss values, and if not (typically with smaller municipal utilities and electric cooperatives), the MN DER assumes 8%. Price suppression and reduced risk have not been addressed by the MN DER or the Minnesota Public Utilities Commission (MN PUC). (Personal Communication with MN DER Staff).

The MN PUC provides the environmental externality values that should be used by the utilities in their CIPs. The MN PUC provides high and low ranges of values at the urban, metropolitan fringe, and rural levels for sulfur dioxide, particulate matter, carbon dioxide, nitrogen oxides, lead, and carbon monoxide, adjusted annually for inflation. The MN PUC previously established an estimate of the likely range of costs of future carbon dioxide regulation on electricity generation of $9 per ton to $34 per ton for carbon dioxide emitted in 2012 and thereafter. This range of values is updated annually. (MN PUC 2013). The utilities will use these values in some instances, but have generally been more focused on including benefits associated with avoided energy, capacity, and T&D, and may not account for the avoided cost of future environmental compliance. (Personal Communication with MN DER Staff).

Minnesota accounts for other program benefits in its cost-effectiveness analyses through its treatment of low-income programs. The MN DER has previously not required low-income programs to pass the Societal Cost test due to their unique purpose and the spending requirement for low-income projects; however, the cost-effectiveness of the programs is still evaluated. (MN DER 2012, p 10). While other non-energy benefits have been discussed and considered by the MN DER, no other non-energy benefits are included in Minnesota energy efficiency cost-effectiveness analyses. Instead, the state has been more focused on other program challenges, and has limited resource available to devote to the development of non-energy benefits. (Personal Communication with MN DER Staff).

4.6 New York

New York's primary energy efficiency policy was founded in its current form on June 23, 2008 through a New York Public Service Commission (NY PSC) order that adopts energy efficiency targets and establishes a process for approval of energy efficiency programs administered by the state's electric utilities and New York State Energy Research and Development Authority (NYSERDA). Among other findings, the order requires the use of the TRC test for cost-effectiveness screening.

As stated in this initial order, the overarching policy that drives New York's energy efficiency practices focuses on maximizing the cost-effective use of limited funding. In attaining New York's Energy Efficiency Portfolio Standard's (EEPS) objectives, the NY PSC stated that "careful attention to program benefit-cost ratios is very important as there is a need to achieve the maximum return on each incremental energy efficiency investment in the context of also achieving other public interest policy objectives and to reduce rate impacts on customers" (NY PSC 2008, p 2).

This policy explains New York's decision to screen programs at the measure level: "The requirement that all measures have a TRC score of at least 1.0 except for some promotional extremely low cost or incidental measures is an important safeguard that ensures that ratepayer funds are spent wisely and efficiently" (NY PSC 2009, p 15).

The NY PSC continued to refine the state's energy efficiency policy through subsequent orders, while the NY PSC Staff defined the technical practices associated with the commission's policies. For example, the NY PSC Staff instructed program administrators to use the utility weighted average cost of capital (WACC) to discount energy efficiency benefits. This is likely because the utility WACC is used for supply side investments, and the NY PSC Staff felt energy efficiency resources are the alternative to supply side resources. (Personal Communication with NY DPS Staff).

The NY PSC has never included wholesale market price suppression as a benefit of energy efficiency programs for cost-effectiveness screening. It was not mentioned or intended in the 2008 order promulgating the TRC with carbon adder as the chief screening test. It was discussed in a 2011 NY PSC Staff white paper that reviewed energy efficiency programs and issues. NY PSC Staff noted briefly that any price suppression would be a transfer payment and not a resource savings. NY PSC Staff noted "the countervailing effect that occurs on the part of the supply side" – leading to only moderate and temporary effects. Lower current and prospective market prices could cause "potential new supply entrants to be dissuaded from entering a market" and "retirements of existing generators may be accelerated." Over the long-term, "a new supply/demand equilibrium is reached, and the price reduction is completely eliminated" (NY DPS 2011, p 31). In the NY PSC's response to the NY PSC Staff white paper, the Commission noted that various TRC test changes discussed in the paper or comments would raise or lower TRC test benefit-cost ratios, and concluded that they would not consider revisions to the TRC test at that time (NY PSC 2011c, p 6).

Similarly, the NY PSC and NY PSC Staff have never included energy efficiency benefits associated with reduced risk as a benefit of energy efficiency programs for cost-effectiveness screening. It was not mentioned or intended in the 2008 order promulgating the TRC with carbon adder as the chief screening test. The order responding to the white paper, however, at length discussed reduced risk of supply disruptions or gas price jumps as a major reason to continue the programs despite current low natural gas prices (NY PSC 2011c, p 5).

The NY PSC has placed emphasis on the benefits associated with avoided costs; therefore, many non-energy benefits have not been explicitly addressed by the NY PSC. However, the NY PSC has generally recognized and considered low-income specific benefits in deciding on funding for utility low-income programs. Specifically, the NY PSC has previously approved non-cost-effective low-income programs, indicating that low-income energy efficiency programs are a beneficial use of energy efficiency funding. (NY DPS 2011, p 37; NY PSC 2010, pp 64-65). Additionally, in TRC screening, the NY PSC Staff will sometimes subtract reduced O&M costs from upfront measure costs as appropriate. For example, reduced O&M costs associated from long-life lighting measures and savings from oil and water may be subtracted from measure costs.

4.7 Oregon

Oregon's consumer-owned utilities must comply with the Northwest Power and Conservation Council's (NPCC) energy efficiency and conservation targets. For efficiency, the most recent targets were established in NPCC's Sixth Northwest Power Plan, which calls for Northwestern states to meet 85% of future regional load growth with energy efficiency and conservation. On the other hand, for investor owned utilities, the plan is advisory but not mandatory. As such, for IOUs, Oregon is committed to procuring all cost-effective energy efficiency measures (Sixth Northwest Power Plan, p 6; Personal Communication with ETO Staff). The Public Utility Commission of Oregon (OR PUC) is interested in the long-term success of energy efficiency in Oregon but sees a need to pace acquisition in order to maintain a delivery infrastructure and moderate rate impact. Thus, the Energy Trust of Oregon, a non-profit created in 1999 to help establish consistency in funding for efficiency and renewable resources, has a twenty-year acquisition schedule (ETO Website 2013).

Since the early 1990s, energy efficiency programs in Oregon have been screened for cost-effectiveness primarily with the Total Resource Cost test at the program level (OR PUC 1994). The Energy Trust of Oregon also screens energy efficiency resources using the Program Administrator Cost test to inform its cost-effectiveness review process (ETO Methodology 2011).

Oregon accounts for the TRC test benefits that accrue over the full life of the energy efficiency measures installed (Personal Communication with ETO Staff). All programs use a discount rate equal to the risk-adjusted cost of capital for utilities, which is established by utilities during each iteration of the IRP process. As of 2009, the rate was 5.2%.

The TRC test used in Oregon includes all other program impacts that are reasonably quantifiable, such as avoided capacity, energy, T&D, line loss, and risk costs, in addition to any resource benefits, including benefits associated with water and gas savings. Although Oregon does not explicitly utilize a carbon price in cost-effectiveness screening, the avoided cost of environmental compliance is embedded in the price forecasts utilized by utilities (Personal Communication with ETO Staff). Additionally, Oregon accounts for risk avoidance by adjusting the benefits of energy efficiency programs for their risk hedge values developed by the NPCC. In the NPCC 5th Power Plan from 2005, the Council evaluated over 1,000 plans against a large number of future conditions and determined that conservation measures above the cost-effectiveness threshold lower cost without adding risk. As such, the Council determined a range of risk avoidance values from $5/MWh of risk avoidance for discretionary programs and $10/MWh for lost opportunity programs (Fifth Northwest Power Plan 2005).

Oregon accounts for all other program impacts that are reasonably quantifiable, and includes a 10% adder in the TRC to reflect benefits that cannot be quantified (OR PUC 1994). This adder works as a "catch-all," accounting for unspecified benefits that accrue directly to participants and are not readily quantifiable.

4.8 Vermont

Vermont's energy efficiency policy is centered on the state's least cost integrated planning mandate, which stipulates that utilities must plan to meet "the public's need for energy services, after safety concerns are addressed, at the lowest present value life cycle cost, including environmental and economic costs, through a strategy combining investments and expenditures on energy supply, transmission and distribution capacity, transmission and distribution efficiency, and comprehensive energy efficiency programs" (30 VSA § 218c). The requirement to include environmental costs lead the Vermont Public Service Board (VT PSB) to its decision to use the Societal Cost test in evaluating energy efficiency programs, because costs in the Societal Cost test include environmental impact, changes in customer satisfaction, local economic impact and risk exposure (VT PSB 1990a, Volume II, Module 4, paragraphs 560, 564). Specifically, the VT PSB concluded that "economic efficiency and environmental integrity are benefits that society values, and evaluation of any DSM program must consider the net change in these benefits to assure that such a program is in society's best interest" (VT PSB 1990a, Volume II, Module 4, paragraph 587).

The use of the Societal Cost test explains Vermont's approach to including other program impacts. Vermont quantifies as many OPIs as can be readily calculated, including operation and maintenance benefits, water savings, and other fuel savings. To account for additional non-energy benefits, a 15% adder is applied to program benefits, and an additional 15% adder is applied to low-income program benefits. The decision to use adders of 15% was based on a literature review conducted by the Vermont Department of Public Service (VT DPS 2011, pp 3-5). In adopting the adders, the VT PSB stated that "while there is a high degree of uncertainty surrounding the magnitude of non-energy benefits, it is clear that the current value of zero is incorrect, and that 15% is on the lower end of the range of estimates" (VT PSB 2012b, p 26).

4.9 Wisconsin

The history of cost-effectiveness screening for energy efficiency programs in Wisconsin provides insight into the state's current cost-effectiveness practices. Legislation from 2005 mandated that funding for energy efficiency programs be capped at 1.2% of operating revenues for gas and electric utilities, but also allowed the Wisconsin Public Service Commission (WI PSC) to request more funding at a future date. As such, following its typical planning process, the WI PSC approached the Joint Committee on Finance and requested additional energy efficiency program funding to meet the level of funding anticipated to be needed to capture all the cost-effective energy efficiency. Soon thereafter, due to state policy decisions beyond the WI PSC's jurisdiction, funding levels for energy efficiency programs were reduced back to the 1.2% operating revenue cap. However, the cost-effectiveness screening policies and practices were not adjusted to reflect the change in funding levels, and continued to operate with the goal of procuring all cost-effective energy efficiency. Now, Wisconsin's primary energy efficiency cost-effectiveness policy is to procure all cost-effectiveness energy efficiency up to the funding cap. (Personal Communication with WI PSC Staff).

Additionally, Wisconsin's screening procedures are informed by certain priorities established by different state and commission policies. According to Wisconsin Act 141, the purpose of energy efficiency programs is to "help achieve environmentally sound and adequate energy supplies at reasonable cost," with a focus on those resources that reduce overall energy use and peak demand. (WI Legislature 196, §69.196.374(2)(a)2)). Further, the WI PSC regulations explain that "the program administrator shall assign priority status to implementing programs that reduce growth in electric and natural gas demand usage, facilitate energy efficiency and renewable resource market development, help market providers achieve higher levels of energy efficiency, promote energy reliability and adequacy, avoid adverse environmental impacts from the use of energy, and promote rural economic development." (WI PSC 2007, §137.05(11)).

As such, Focus on Energy, Wisconsin's energy efficiency program administrator, primarily utilizes what the state refers to as a "modified" TRC test. It is applied at the portfolio level, and accounts for the benefits that accrue over the effective useful life of the measures installed. Both the Wisconsin program administrator and program evaluator apply a low-risk discount rate of 2%, which represents the public sector cost of borrowing and was decided upon by the WI PSC after considering stakeholder feedback on various discount rates.

The WI PSC also requires the program administrator and evaluator to provide the results of two other cost-effectiveness tests: the PAC test, used to inform program design, and an "expanded" version of the TRC test, used to assess additional energy efficiency benefits (WI PSC 2007, §137.05(12)). More specifically, the WI PSC states that "the modified TRC test does not provide useful guidance for appropriate program design, so the Commission finds it reasonable to require that programs must pass the Utility/Administrator test in order to ensure that the benefits ratepayers receive from these programs exceed the programs' costs." Additionally, "the Commission recognizes that other non-economic externalities are also significant, so the expanded test must also be applied at the portfolio level." Wisconsin's "expanded" TRC test falls somewhere in between what are traditionally defined as the TRC test and the Societal Cost test. It includes additional benefits that flow through the economy, including job creation, additional emissions, mercury reductions, increases in comforts, decreases in operation and maintenance costs, etc. The results of the expanded TRC test are only provided every couple of years. (WI PSC 2010; Personal Communication with WI PSC Staff).

In its application of the modified TRC test, Focus on Energy accounts for the avoided costs associated with energy, capacity, line losses, and environmental compliance. Wisconsin does not account for avoided transmission and distribution costs, price suppression or reduced risk. The avoided capacity costs are based on the cost of a new peaking plant and, as of 2012, avoided energy costs are calculated based on a forward-looking average of the locational marginal prices across Wisconsin nodes, and based on MISO data (WI PSC 2012b). Included in these valuations are avoided capacity, line loss and environmental compliance costs. Wisconsin includes a levelized carbon value of $30 per ton in assessing the emissions benefits of a given resource. Additionally, because Focus on Energy offers joint gas and electric programs, gas benefits are calculated and included in the modified TRC test analysis. Other participant-perspective OPIs are excluded from the modified TRC test, and are only included in the expanded TRC test.

5. Comparison of Michigan's Screening Practices to Other Jurisdictions

5.1 Cost-Effectiveness Tests

Michigan is one of the few states that relies on the PAC test as its primary test. In fact, only one of the eight states we surveyed, and only five states throughout the United States use the PAC test as their primary test. Five out of the eight states surveyed rely on the TRC test, and 29 states in the United States use the TRC test as the primary cost-effectiveness test. Two out of the eight states surveyed, and 6 states in the United States rely on the Societal Cost test as the primary cost-effectiveness test (ACEEE 2012a, p 13). Below we discuss the advantages and disadvantages of the three primary cost-effectiveness tests.

The Societal Cost test is the most comprehensive test, and is most appropriate for those states that wish to give consideration to the societal benefits of energy efficiency programs, particularly the environmental and health benefits. The disadvantages of this test are that some stakeholders may view the scope as outside the interests and jurisdiction of regulatory commissions; some of the societal impacts are uncertain and difficult to forecast; and this test could increase the range of cost-effective programs, which might lead to higher cost impacts on utility customers.

The TRC test is the next most comprehensive test, and is the most widely used test. Regulators and legislators are apparently drawn to this test because it intends to evaluate the majority of the costs and benefits for all ratepayers. However, the TRC test creates a dilemma for policymakers. In order to be internally consistent the test must include other program impacts on the program participants, but regulators are often wary of doing so because some of the costs are uncertain and difficult to quantify. In addition, some stakeholders are concerned that including OPIs in the assessment of energy efficiency could lead to utility customers paying higher costs for efficiency programs in order to pay for other program benefits that are not in their interest and should not be paid for through utility rates.

The PAC test is most appropriate for those states that want to limit the energy efficiency cost-effectiveness analysis to the impacts on revenue requirements. There are many advantages to this test: it is consistent with the way that supply-side investments are evaluated; it includes costs that are relatively easy to identify and quantify; and it includes the energy costs and energy benefits that are most important to utility regulators. Probably the most important benefit of the PAC test is that it provides legislators, regulators, consumer advocates and others with confidence that the energy efficiency programs will result in lower costs to utility customers. This is an extremely important consideration, particularly for those states that seek to implement all cost-effectiveness energy efficiency resources.

However, relying on the PAC test has one significant disadvantage in that the costs and benefits to energy efficiency program participants are not taken into consideration. There are two implications of this. First, by not including the participant's cost the PAC test does not include the full incremental cost of efficiency measures, which may be important to policymakers who may be concerned about the total economic impact of the energy efficiency programs. Second, the PAC test does not include the other program benefits of efficiency measure, some of which are clearly important to policy makers. The other program benefits that are typically most important to regulators are (a) those benefits that pertain to low-income customers, because of the significant public policy implications of this sector; and (b) the other fuel savings, because these savings are important to promote comprehensive, whole-house, one-stop-shopping residential retrofit programs as well as new construction programs where customers tend to use multiple fuels.

5.2 Secondary Test

In addition to relying on the PAC test as its primary cost-effectiveness test, Michigan also considers the results of the TRC, RIM, and Participant Cost tests. Michigan's approach to considering multiple cost-effectiveness tests is comprehensive. Five out of the eight surveyed states consider secondary cost-effectiveness tests, three of which consider multiple cost-effectiveness tests. The TRC and PAC tests are most commonly used by these states as their secondary screening tests. Three states rely on the primary test only, and do not consider the results of other cost-effectiveness tests.

The advantage to using multiple screening tests is that multiple policy objectives can be evaluated through different tests. For example, Wisconsin uses the TRC test as its primary cost-effectiveness test, but uses the PAC test to help inform program design (e.g., whether an incentive level is appropriate) and whether ratepayer funding is spent wisely. Applying multiple tests allows for balancing achievement of various key public policy objectives, such as accounting for the full incremental cost of the efficiency measure, accounting for other program impacts, and accounting for societal benefits, or ensuring a net reduction in costs to customers.

The downside to using multiple screening tests is that it still leaves the ultimate question of which programs to implement, and that, in practice, it is more common and straightforward to use a single, primary test to answer this ultimate question. Further, preparing and analyzing multiple test results is cumbersome, and places additional administrative burdens on the utilities, regulators, and stakeholders.

5.3 Screening Level

Michigan applies its cost-effectiveness tests primarily at the portfolio level, but also considers screening results at the program and measure levels. As the primary screening level, four of the surveyed states screen for cost-effectiveness at the program level, three consider the portfolio level, one state screens at the sector level, and one state screens at the measure level.[10] Six of the surveyed states consider cost-effectiveness results at other screening levels, while two states do not. Across the country, 30 states apply cost-effectiveness tests at the portfolio level, 30 states apply cost-effectiveness tests at the program level, and 13 states apply cost-effectiveness test at the measure level (ACEEE 2012a, p 31).

Evaluating cost-effectiveness at the measure level means that each individual component (i.e., measure, equipment, or other action) of an efficiency program must be cost-effective. Screening at the measure level is the most restrictive application of the cost-effectiveness tests, and can create a barrier to greater savings levels. (NAPEE 2008, pp.3-9, 3-10).

Evaluation at the program level means that collectively the measures under a program must be cost-effective, but some measures can be uneconomical if there are other measures that more than make up for them. While non-cost-effective measures may reduce a program's overall cost-effectiveness, the program administrator may be able to achieve greater overall savings through the combination of measures. Additionally, a measure may not be cost-effective on its own, but may become cost-effective when combined with other efforts. (NAPEE 2008, pp 3-9, 3-10).

Evaluating cost-effectiveness at the portfolio level means that all of the programs taken together must be cost-effective, but individual programs can be positive or negative. This is the most flexible application of cost-effectiveness testing, as program administrators have the ability to experiment with different strategies and technologies that may not be immediately cost-effective or require further testing, such as pilot programs, market transformation programs, or emerging technologies. (NAPEE 2008, pp 3-9, 3-10).

Further, the advantages and disadvantages of applying multiple screening levels are similar to applying multiple cost-effectiveness tests. The advantage is that regulators can ensure cost-effectiveness at the most granular level, or the highest level. The disadvantage is that it can result in an overwhelming level of analysis, especially when provided at the measure level.

5.4 Discount Rate

To discount the future stream of benefits, Michigan relies on the utility weighted average cost of capital. Five of the surveyed states also rely on the weighted average cost of capital, two states use a low-risk rate, and two states rely on a societal discount rate.[11] As indicated in Table 2, there is a wide range of discount rates used, both in terms of the rationale for the discount rate and the values chosen for a given rationale. Even states that use the same rationale for choosing a discount rate (e.g., relying on the

[10] Note that Illinois relies on both the portfolio and program level screening results, depending on the statue to which a program corresponds. (220 ILCS 5/8-103,§103(a); 5/16-111.5B).

[11] Note that Minnesota relies on both a societal discount rate utility discount rate in its primary cost-effectiveness test. (MN DER Staff 2012, Inputs 11-13; Xcel 2012a, p 481).

weighted cost of capital) have very different values for the actual rates used (e.g., 3.93% to 10% for the weighted cost of capital).

Discount rates are commonly used to compare future streams of costs in a consistent way, by estimating the present value of the costs and expressing them in a common reference year. The choice of discount rate will have a significant impact on the present value of costs and benefits; relatively high discount rates will significantly reduce the value of costs and benefits in the later years of the study period, while relatively low discount rates will reduce that value by much less. A discount rate of zero means that costs and benefits in future years are valued as much as costs and benefits today. The choice of discount rates is especially important for energy efficiency resources, whose costs are typically incurred in early years while benefits are experienced in later years.

Discount rates are used to account for two interdependent concepts: the time value of money and the riskiness of the investment (Synapse 2012b). The time value of money is captured in the cost of capital that an investor uses to finance an investment; and the cost of capital is one of the key determinants of the discount rate. The riskiness of an investment is an indication of the project risk and or portfolio risk; and those investments that are expected to have a low project risk or portfolio risk can be discounted using a relatively low discount rate to reflect that risk.

Energy efficiency programs financed by a system benefits charge, or a similar fully-reconciling charge, represent a funding source with a low financial risk. Energy efficiency resources also represent low project and portfolio risk. A state could account for the low risk of energy efficiency resources by applying a low-risk discount rate. A low-risk discount rate could, for example, be based on a general indicator of low-risk investments, such as US Treasury bonds. To account for the low project risk, a state could reduce the low-risk discount rate further solely on the basis of the cost of capital.

In some cases, a state will chose a discount rate based on the cost-effectiveness test. For example, in Vermont and Minnesota, the societal discount rate is chosen because the state has chosen to use the Societal Cost test to screen energy efficiency. While there is sound logic in applying a societal discount rate when using the Societal Cost test, it is not entirely clear what the societal discount rate represents in these cases. First, there is a range of discount rates that could be used to reflect society's perspective. Second, it is not clear to what extent this choice of discount rate is intended to account for reduced financial, project and/or portfolio risk.

5.5 Avoided costs

Energy efficiency resources have the potential to avoid a number of utility system costs, thereby producing substantial benefits to utilities and customers. Michigan does not include two avoided costs in its cost-effectiveness analyses: price suppression benefits and reduced risk benefits.

The advantages to these two avoided costs are the same. These two types of avoided costs provide important benefits, and should be accounted for in cost-effectiveness screening. Otherwise, the cost-effectiveness test results are skewed against energy efficiency as not all benefits are incorporated.

Therefore, the advantage of including the avoided costs in cost-effectiveness testing is that it provides for a complete representation of energy efficiency resources benefits.

The only disadvantage of including these types of avoided costs may be that they are difficult to estimate, or the results may be seen as too uncertain to include in the cost-effectiveness analysis.

Below, we provide a more detailed comparison analysis as well as the rationale for including these two benefits. Appendix B provides additional information on best practices for some of the issues identified below.

Price Suppression

Michigan, along with six out of the eight states in our survey, does not include the benefits of market price suppression in its cost-effectiveness screening. Only Massachusetts and Connecticut incorporate price suppression benefits, which are developed for the states as part of New England's regional avoided energy supply cost study (see Synapse 2013a).

Wholesale market price suppression effects could be included as a benefit of energy efficiency in regions with competitive wholesale electric markets. Even a small reduction in a market clearing price can result in significant cost reductions across the entire market. States could include price suppression effects as a benefit of energy efficiency because it represents a reduction in costs to wholesale electric customers, which are passed on to retail electric customers. This benefit could be included in the PAC test, the TRC test, and the Societal Cost test.[12]

Reduced Risk

Most of the states we surveyed, including Michigan, do not recognize that energy efficiency may reduce risks on the utility system associated with supply-side resources. Only Oregon and Vermont account for the benefits associated with reduced risk, which they accomplish by applying an adder of 10% and 15% to program benefits, respectively. Additionally, Oregon accounts for risk avoidance using specific dollar per MWh saved factors, which are based on the risk hedge values of certain efficiency programs.

Energy efficiency can mitigate the various risks associated with large, conventional power plants. A recent study evaluated the costs and risks of various energy resources, and found that energy efficiency is the least cost and least risky electricity resource (Ceres 2012). Given the potential value of reduced risk and the many ways that energy efficiency can reduce utility system risks, states could consider explicitly accounting for the risk benefits of energy efficiency.

5.6 Other Program Impacts

OPIs could be included in cost-effectiveness tests for which the relevant costs and benefits are applicable. If any one test includes some of the costs (or benefits) from one perspective, but excludes

[12] A recent study by ACEEE evaluated wholesale price mitigation impacts from energy efficiency programs for Ohio. See ACEEE 2013.

some of the costs (or benefits) from that same perspective, then the test results may be skewed; i.e., they may not provide an accurate indication of cost-effectiveness from that perspective. (Synapse 2012b; Neme and Kushler 2010).

The states in our survey use different approaches for including OPIs in cost-effectiveness analyses, with some states not including such benefits at all. Below we discuss three important categories of OPIs.

Resource benefits

Michigan does not account for savings from other resources such as natural gas and water that participants can experience from energy efficiency resources, primarily because the state relies on the PAC test which does not take into account participant benefits. Except for Connecticut, which also relies on the PAC test as its primary cost-effectiveness test, all of the states in our survey except for Minnesota quantify other resource savings to some extent.

Among the participant-perspective OPIs that could be included in the TRC test, other fuel savings deserve particular consideration. First, this type of OPI tends to have one of the biggest impacts on the cost-effectiveness of certain programs. Second, this type of OPI tends to support important public policy goals of regulators and other stakeholders. Other fuel savings are important because they help justify comprehensive residential retrofit and residential new construction programs that are designed to treat multiple fuels in customers' homes. (Synapse 2012b, p 24).

Michigan could include resource benefits in its PAC test results as an alternative scenario as it is an important public policy goal. The advantage of including such benefits is that it allows for a more comprehensive analysis. Resource benefits could be included in Michigan's TRC test results as well.

Utility OPIs

Michigan does not include the non-energy benefits that accrue to utilities as a result of energy efficiency resources. Most of the states in our survey do not include such benefits either, although Massachusetts does directly quantify utility-perspective OPIs, and Vermont and Oregon account for such benefits through a 15% and 10% adder applied to program benefits, respectively.

Because Michigan relies on the PAC test, its cost-effectiveness analyses could include utility-perspective OPIs. Utility-perspective OPIs are generally considered to be small relative to other OPIs. However, some studies have identified significant benefits associated with reduced shutoffs and reconnects, as well as bad debt write offs and carrying costs on arrearages. In addition, utility-perspective OPIs can be significantly larger for low-income customers, particularly in states where low-income customers are offered discounted rates or shutoff protection provisions that can sometimes result in large arrearages.

Similar to avoided costs, the advantage of including utility OPIs is simply that it is more accurate and comprehensive to include them.

Participant OPIs

Michigan effectively considers a portion of participant-perspective OPIs in the PAC test analysis by permitting low-income programs to be less cost-effective. Our survey results indicate that states treat the participant-perspective OPIs very differently. Massachusetts is the only state in our survey that directly quantifies utility- and participant-perspective OPIs, while Vermont and Oregon apply a 15% adder and 10% adder to their benefits, respectively. Several states include few or no non-energy benefits, despite using the TRC test or Societal Cost test as the primary test. However, some of these states consider resource benefits and qualitatively consider low-income benefits.

While Michigan should not include participant-perspective OPIs in its PAC test as that would be inconsistent with the test's perspective, it could in its TRC test and Participant Cost test analyses. As mentioned above, OPIs could be included in cost-effectiveness tests for which the relevant costs and benefits are applicable. If a state has chosen to use the TRC test as the primary screening test, then the cost-effectiveness analysis could include utility- and participant-perspective OPIs. The TRC test should not be used to screen energy efficiency resources if participant-perspective OPIs are not adequately accounted for. The TRC test includes all the costs to program participants, and therefore it must also include all the benefits to program participants in order to maintain internal consistency. Otherwise the test results may be inherently skewed against energy efficiency.

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Appendix A – State Cost-Effectiveness Survey Results

Table A.1: Michigan

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Reduce the future costs of service to customers	**Source**: Act 295, § 71(1)(a); Personal Communication with MI PSC Staff. **Note**: "The overall goal of an energy optimization plan shall be to reduce the future costs of provider service to customers. In particular, an EO plan shall be designed to delay the need for constructing new electric generating facilities and thereby protect consumers from incurring the costs of such construction." The state's immediate goal was to quickly and efficiency implement programs as there were previously none.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Program Administrator Cost Test	**Source**: Act 295, § 73(2). **Note**: "The commission shall not approve a proposed energy optimization plan unless the commission determines that the EO plan meets the utility system resource cost test and is reasonable and prudent."
	Other Test(s) considered (if applicable)	TRC, RIM, Participant Cost	**Source:** MI PSC 2008, Appendix E, 1.e. **Note**: "In order to provide the Commission with sufficient information to support the proposed distribution of energy optimization funds among the portfolio of proposed programs, the filed plan will include multiple cost-effectiveness tests for individual programs including: USRCT, Total Resource Cost Test, Rate Impact Measure Test and Participant Cost Tests."
	Level at which Test(s) is applied	Portfolio	**Source:** MI PSC 2008, Appendix E, 2.a. **Note**: "Cost effective means that the overall plan being evaluated meets the Utility System Resource Cost Test."
	Other level(s) at which Test(s) is applied (if applicable)	Program, Measure	**Source:** MI PSC 2008, Appendix E, 1.e; Personal Communication with MI PSC Staff. **Note**: "In order to provide the Commission with sufficient information to support the proposed distribution of energy optimization funds among the portfolio of proposed programs, the filed plan will include multiple cost-effectiveness tests for individual programs."
	Discount rate used in Test(s)	Utility WACC	**Source:** Consumers Energy 2012, p 18; Detroit Edison 2009, Morgan Testimony, RAM-17; Personal Communication with MI PSC Staff. **Note**: The discount rate is based on a utility's weighted average cost of capital, which varies by utility. The utilities' typical discounts rates range between 7% and 10%, and are about 8% on average. Consumers Energy uses a discount rate of 9.78% for both energy efficiency programs and supply side resources.
	Study period over which Test(s) is applied	Measure Life	**Source**: Personal Communication with MI PSC Staff. **Note**: The deemed savings database previously limited measure lives to 20 years, but that cap has since been lifted to allow for the full lifetime of the measures installed.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source**: MI PSC 2008, Appendix E, 2.f. **Note**: The Utility Cost Test takes into account the avoided supply costs of demand and capacity valued at marginal costs for the periods when there is a load reduction. At the option of the provider, either the cost-based value provided by the commission or the MISO market-based value can be used as a determinant in estimating the avoided cost.
	Energy Costs	Yes	**Source**: MI PSC 2008, Appendix E, 2.f. **Note**: The Utility Cost Test takes into account the avoided supply costs of energy and generation. At the option of the provider, either the cost-based value provided by the commission or the MISO market-based value can be used as a determinant in estimating the avoided cost.
	T&D Costs	Yes	**Source**: MI PSC 2008, Appendix E, 2.f; Personal Communication with MI PSC Staff. **Note**: The Utility Cost Test takes into account the reduction in transmission and distribution, although the avoided cost varies by utility and can be relatively low.
	Environmental Compliance	No	**Source**: MI PSC 2008, Appendix E, 2.f; Personal Communication with MI PSC Staff. **Note**: The avoided supply costs of future carbon tax has been included for renewable energy programs, but not for energy efficiency programs. Current environmental compliance costs are embedded in avoided energy costs.
	Price Suppression	No	
	Line Loss Costs	Yes	**Source**: Personal Communication with MI PSC Staff; Consumers Energy 2012, pp 18-19. **Note:** The Utility Cost Test takes into account the avoided cost of transmission and distribution line losses. For example, the Consumers Energy line loss study was used to value losses at the secondary, primary, and transmission voltage levels.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** Act 295, § 71(3)(g). **Note**: Low-income program offerings are excluded from the cost-effectiveness requirement.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	No	**Source:** Personal Communication with MI PSC Staff. **Note:** Natural gas savings are quantified in natural gas programs, but are not included in electric energy efficiency programs.
	Low-Income	Yes - Qualitative	**Source:** Act 295, § 71(3)(g). **Note**: Low-income program offerings are excluded from the cost-effectiveness requirement.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.2: Connecticut

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Focus on electric system impacts only	**Source:** CT DPUC 1999.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Program Administrator Cost Test	**Source**: DEEP 2012, pp 19-20. **Note**: Also referred to as the Utility Cost Test, Electric System Test, or Gas System Test.
	Other Test(s) considered (if applicable)	TRC	**Source**: DEEP 2012, pp 19-20.
	Level at which Test(s) is applied	Program	**Source:** CT G.S. §16-245m (d)(1).
	Other level(s) at which Test(s) is applied (if applicable)	n/a	
	Discount rate used in Test(s)	Cost of Capital	**Source**: Connecticut Utilities 2011, pp 331. **Note**: Each CT utilities' after-tax cost of capital is weighted by utility, and the weighted average cost of capital is used by all utilities. The average is compared to 7%, and the higher value is used. The current rate is 7.43% for electric programs. The inflation rate of 2 percent based on the 2011 AESC.
	Study period over which Test(s) is applied	Measure Life	**Source**: Connecticut Utilities 2011, p 323.
Avoided Costs Included in Primary Cost-Effectiveness Test	Capacity Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-322. **Note**: Values from Synapse 2011.
	Energy Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-324. **Note**: Values from Synapse 2011.
	T&D Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-323, 326-328. **Note**: Values from independent consultant quantifications.
	Environmental Compliance	Yes	**Source**: Connecticut Utilities 2011, pp 320-322, 329. **Note**: Values from Synapse 2011.
	Price Suppression	Yes	**Source**: Connecticut Utilities 2011, pp 320-322, 327-328. **Note**: Values from Synapse 2011.
	Line Loss Costs	Yes	**Source**: Connecticut Utilities 2011, pp 320-322, 327-328; Personal Communication with CT DEEP Staff. **Note**: Values from Synapse 2011.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Test(s)?	Yes	
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	No	
	Low-Income	Yes - Qualitative	**Source**: CT DPUC 1999; CT DPUC 2010. **Note**: Low-income programs that do not pass the cost-effectiveness test are still approved due to additional benefits that accrue to low-income customers.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.3: Illinois

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Diverse program offerings to customers	**Source:** 220 ILCS 5/8-103, § 8-103(f)(5). **Note**: "The utility shall demonstrate that its overall portfolio of energy efficiency and demand-response measures... represent a diverse cross-section of opportunities for customers of all rate classes to participate in the programs."
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** 220 ILCS 5/8-103,§103(a). **Note**: "cost-effective" means that the measures satisfy the total resource cost test.
	Other Test(s) considered (if applicable)	PAC	**Source:** 220 ILCS 5/16-111.5B(a)(3)(D); ComEd 2013b, p 26. **Note:** Show that "the new or expanded cost-effective energy efficiency programs or measures would lead to a reduction in the overall cost of electric service."
	Level at which Test(s) is applied	Portfolio or Program	**Source**: 220 ILCS 5/8-103,§103(a); 5/16-111.5B. **Note**: Section 8-103 programs are required to screen at the portfolio level. IPA programs are required to screen at the program level.
	Other level(s) at which Test(s) is applied (if applicable)	Portfolio, Program, Measure	**Source**: ICC 2010, p 30; Personal Communication with ICC Staff. **Note**: The Commission finds that evaluating cost-effectiveness on a portfolio level is necessary to ensure that Ameren not be penalized for planning assumptions that turn out to be inaccurate. The Commission concludes it is appropriate to apply the TRC test at the portfolio level, but Ameren Illinois and the DCEO should be allowed to apply it at the measure or program level if they so choose.
	Discount rate used in Test(s)	WACC	**Source:** Ameren 2013b, Testimony of Andrew Cottrell, p 10; Exh. 1.1, App. D, Vol. 3, p 2-23. **Note:** Ameren Illinois used the corporate weighted average cost of capital. Ameren's nominal discount rate is 7% with an inflation rate of 2.92%, for a real discount rate of 3.93%.
	Study period over which Test(s) is applied	Measure Life	**Source**: 20 ILCS 3855/1-10. **Note**: "The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net present value of the total costs as calculated over the lifetime of the measures."
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** Ameren 2013b, pp 26-27.
	Energy Costs	Yes	**Source:** Ameren 2013b, pp 25-26.
	T&D Costs	Yes	**Source:** Ameren 2013b, pp 27-29.
	Environmental Compliance	Yes	**Source:** 20 ILCS 3855/1-10. **Note**: In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases.
	Price Suppression	No	**Source:** See ICC 2012, p 270.
	Line Loss Costs	Yes	**Source:** Ameren 2013b, Testimony of Andrew Cottrell, pp 9-10; Exh. 1.1, App. D, Vol. 3, p 2-23. **Note**: Each avoided cost is adjusted upwards in the TRC calculation by the appropriate line loss factor. Ameren uses an electric delivery losses factor of 6.7% and a natural gas delivery losses factor of 0.0085%.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source**: 20 ILCS 3855/1-10. **Note**: A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, as well as other quantifiable societal benefits, including avoided natural gas utility costs.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	Yes - Quantified	**Source:** 20 ILCS 3855/1-10; Ameren 2013b, pp 24-25. **Note**: Natural gas and water.
	Low-Income	Yes - Qualitative	**Source:** 220 ILCS 5/8-103,§103(a). **Note**: Low-income measures shall not be required to meet the total resource cost test.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.4: Massachusetts

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		All available cost-effective energy efficiency	**Source:** MA G.L. c. 25.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** MA DPU 2013a, Guidelines § 3.4.3.
	Other Test(s) considered (if applicable)	n/a	
	Level at which Test(s) is applied	Program level	**Source:** MA DPU 2013a, Guideline § 3.4.3.1. **Notes:** Hard-to-measure EE programs are screened at the customer sector level. MA EE Guidelines, § 3.4.3.2.
	Other level(s) at which Test(s) is applied (if applicable)	n/a	
	Discount rate used in Test(s)	10 year Treasury Note	**Source:** MA DPU 2013a, Guideline § 3.4.6. **Note:** "A discount rate that is equal to a twelve-month average of the historic yields from the ten-year United States Treasury note, using the previous calendar year to determine the twelve-month average." In the 2013-2015 plans, the nominal discount rate was 2.78% and the real discount rate was 0.55%.
	Study period over which Test(s) is applied	Measure Life	25 years.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(i). **Note:** Values from Synapse 2011.
	Energy Costs	Yes	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(ii). **Note:** Values from Synapse 2011.
	T&D Costs	Yes	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(a)(iii), (iv). **Note:** Values developed individually by Program Administrators.
	Environmental Compliance	Yes	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(v). **Notes:** "Reasonably projected to be incurred in the future." Values from Synapse 2011.
	Price Suppression	Yes	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(a)(vi), (vii). **Notes:** Both capacity and energy price suppression. Values from Synapse 2011.
	Line Loss Costs	Yes	**Note:** Values from Synapse 2011.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(a)(viii), (b)(ii). **Note:** Each OPI is explicitly quantified.
	Program Administrator or Utility OPIs	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(a)(viii). **Note:** Each OPI is explicitly quantified.
	Participant or Customer OPIs:		**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Note:** Each OPI is explicitly quantified.
	Resource	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(i). **Notes:** Includes natural gas, oil, propane, wood, kerosene, water, other. Each OPI is explicitly quantified.
	Low-Income	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii)(D). **Notes:** Includes all benefits associated with providing energy efficiency services to Low-Income Customers. Each OPI is explicitly quantified.
	Equipment	Yes - Quantified	**Source:** MA DPU 2013a, Guidelines § 3.4.4.1(b)(ii)(A), (B). **Notes:** Includes reduced costs for operation and maintenance associated with efficient equipment or practices, the value of longer equipment replacement cycles and/or productivity improvements associated with efficient equipment. Each OPI is explicitly quantified.
	Comfort	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Note:** Each OPI is explicitly quantified.
	Health & Safety	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii)(C). **Notes:** Includes reduced environmental and safety costs, such as those for changes in a waste stream or disposal of lamp ballasts or ozone-depleting chemicals. Each OPI is explicitly quantified.
	Property Value	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Note:** Each OPI is explicitly quantified.
	Utility Related	Yes - Quantified	**Source:** MA DPU 2013a, Guideline § 3.4.4.1(b)(ii). **Notes:** Includes reductions in all costs to the electric distribution company associated with reduced customer arrearages and reduced service terminations and reconnections. Each OPI is explicitly quantified.
	Societal OPIs	No	**Source:** MA DPU 2013b, pp 105-106. **Note:** The MA DPU explicitly directed the removal of certain societal OPIs from TRC test.

Table A.5: Minnesota

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Achieve annual savings goal of 1.5% of sales	**Source:** MN Statute 216B.241, Subp. 1c; Personal Communication with MN DER Staff.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Societal Cost Test	**Source:** MN Rules 7690.1200, Subp. 1(c); MN DOC 2011, p 7. **Note**: Although Minnesota Rules require utilities to file cost-effectiveness results from all four perspectives, DER focuses on the Societal test as it measures the ratio of overall benefits and costs to society of energy conservation improvements.
	Other Test(s) considered (if applicable)	PAC, Participant Cost, TRC, RIM	**Source:** MN Rules 7690.1200, Subp. 1(c); MN Rules 7690.0550, Subp. E; Personal Communication with MN DER Staff. **Note**: a utility should provide information on the cost-effectiveness of its programs, as calculated from the utility, participant, ratepayer, and societal perspectives.
	Level at which Test(s) is applied	Segment (essentially Sector)	**Source:** MN DER 2012, pp 9-10. **Note**: In April 2012, the DER announced a policy for 2013-2015 CIP plans that requires portfolios to be cost-effective at the segment level, rather than the program level. Segments include business; residential; low-income; planning; research, evaluations and pilots; renewable energy; and assessments.
	Other level(s) at which Test(s) is applied (if applicable)	Portfolio, Program, Measure	**Source:** Personal Communication with MN DER Staff. **Note:** The MN DER reviews cost-effectiveness results at the portfolio and program levels, and sometimes at the measure level.
	Discount rate used in Test(s)	Social Discount Rate, WACC	**Source:** MN DER Staff 2012, Inputs 11-13; Xcel 2012a, p 481. **Note**: The Societal Discount Rate is based on the US Treasury's 20-year constant maturity rate, which was 2.67% as of January 3, 2012. The Utility Discount Rate is a utility's weighted cost of capital approved in the utility's most recent rate case. Xcel Energy's WACC was 7.04% in the utility's 2010 rate case. For the Societal Cost test, residential programs use the societal discount rate, and commercial programs use the utility discount rate. The Participant Test uses the societal discount rate, and the PAC test uses the utility discount rate.
	Study period over which Test(s) is applied	15 years	**Source:** MN DER Staff 2012, Input 20; Personal Communication with MN DER Staff. **Note**: The Project Life is the expected lifetime of a particular energy conservation measure, expressed in number of years. The measure life is capped at 15 years.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** Xcel 2012a, p 478; Xcel 2012b. **Note:** Avoided Generation included in Avoided Revenue Requirements.
	Energy Costs	Yes	**Source:** Xcel 2012a, p 478; Xcel 2012b. **Note:** Avoided Marginal Energy included in Avoided Revenue Requirements; Bill Reduction included in Participant Benefits.
	T&D Costs	Yes	**Source:** Xcel 2012a, p 478; Xcel 2012b. **Note:** Avoided T&D included in Avoided Revenue Requirements.
	Environmental Compliance	Yes	**Source:** Xcel 2012a, p 478; MN PUC 2013. **Note:** Avoided Environmental Externality included in Avoided Revenue Requirements.
	Price Suppression	No	
	Line Loss Costs	Yes	**Source:** Personal Communication with MN DER Staff. **Note:** Typically the utility will provide line loss values. If not, the MN DER will assume 8%.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** Xcel 2012a, p 478.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	No	
	Low-Income	Yes - Qualitative	**Source:** MN DER 2012, p 10. **Note:** Due to their unique purpose and the spending requirement for low-income projects, the Commissioner has not required low-income programs to pass the Societal Cost test in previous triennials.
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.6: New York

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
	Primary Policy Driver	Maximize cost-effectiveness given limited funding	**Source:** NY PSC 2008.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** NY PSC 2008, App. 3.
	Other Test(s) considered (if applicable)	n/a	**Source:** Personal Communication with NY DPS Staff; ConEdison 2013. **Notes:** A couples of times in recent years rate impact assessments were considered as part of energy efficiency screening.
	Level at which Test(s) is applied	Measure Level	**Source**: Personal Communication with NY DPS Staff; NY PSC 2011a, p 10. **Note:** Measures are pre-screened for cost-effectiveness.
	Other level(s) at which Test(s) is applied (if applicable)	Project, Program	**Source**: Personal Communication with NY DPS Staff; NY PSC 2011a, p 10. **Note:** Project level screenings are conducted and are not provided to the DPS staff but are subject to audit. New programs are often screened at the program level, but the results do not impact the DPS's determination.
	Discount rate used in Test(s)	Utility Weighted Debt/Equity Cost of Capital	**Source:** NYSERDA 2011, p 8-8; Personal Communication with NY DPS Staff. **Notes:** Currently 5.5% real, 7.72% nominal.
	Study period over which Test(s) is applied	Measure Life	**Source**: NYSERDA 2011, p 8-8; NYDPS; NY PSC 2011b. **Notes:** Estimated mean measure lifetime.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** NY PSC 2009a, pp 33-38. **Notes:** Generation is based on FERC price-setting and NYISO market values, with projections based on need date.
	Energy Costs	Yes	**Source**: NY PSC 2009a, pp 33-38. **Notes:** Baseline year historic NYISO LBMPs with projections based on MAPS simulations.
	T&D Costs	Yes	**Source:** NY PSC 2009a, pp 33-38. **Notes**: Values established by tariff studies. Avoided transmission costs embedded in avoided energy costs.
	Environmental Compliance	Yes	**Source:** NY PSC 2008. **Notes:** credit for avoided CO2 emissions at $15/ton
	Price Suppression	No	
	Line Loss Costs	Yes	**Source:** NY PSC 2009a, App. 2. **Note:** Divide marginal costs by 0.928 or multiply the savings by (1+7.76%). Avoided transmission line loss costs embedded in avoided energy costs.
	Reduced Risk	No	
	Other Avoided Costs	No	
OPIs/NEBs Included in Cost-Effectiveness Test(s)	Are OPIs included in Test(s)?	Yes	**Source:** NY PSC 2008; Personal Communication with NY DPS Staff. **Note:** The DPS provides guidelines for program administrators to report various OPIs qualitatively. In practice, only CO2 and low income benefits have been incorporated into screening practices.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	Yes - Quantified	**Source:** Personal Communication with NY DPS Staff. **Notes:** Includes water and other fuels. Can be modeled as a reduced O&M cost as subtracted from measure costs.
	Low-Income Only	Yes - Qualitative	**Source:** NY PSC 2010, pp 64-65. **Note:** Co-benefits considered as part of qualitative analysis, including effect on low-income customers. At least one low-income program was approved despite a TRC ratio less than 1.0.
	Equipment	Yes - Qualitative	**Source:** Personal Communication with NY DPS Staff. **Notes:** Flexibility for O&M savings.
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Table A.7: Oregon

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		All-Cost Effective Measures	**Source:** Sixth Northwest Power Plan, p 6; Personal Communication with ETO Staff. **Note:** "Cost-effective energy efficiency should be developed aggressively and consistently for the foreseeable future. The Council's plan demonstrates that cost-effective efficiency improvements could on average meet 85 percent of the region's load growth over the next 20 years."
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Total Resource Cost Test	**Source:** OR PUC 1994. **Note:** The docket calls for an amended application of the TRC as it only examines benefits direct to the utility and ratepayers.
	Other Test(s) considered (if applicable)	PAC	**Source:** ETO Methodology 2011.
	Primary Level at which Test(s) is applied	Program	**Source:** OR PUC 1994.
	Other level(s) at which Test(s) is applied (if applicable)	Measure	**Source:** OR PUC 1994.
	Discount rate used in Test(s)	Risk-adjusted cost of capital	**Source:** Personal Communication with ETO Staff. **Note:** Risk-adjusted cost of capital, as established by Utility IRPs and accepted/allowed by the PUC. As of 2009, it was 5.2%.
	Study period over which Test(s) is applied	Measure Life	**Source:** Personal Communication with ETO Staff.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** ETO Methodology 2011.
	Energy Costs	Yes	**Source:** ETO Methodology 2011, p 2.
	T&D Costs	Yes	**Source:** ETO Methodology 2011.
	Environmental Compliance	Yes	**Source:** Personal Communication with ETO Staff. **Note:** Avoided environmental compliance costs are embedded in market predictions. For instance, carbon regulation risk is assumed to be included in price forecasts utilized by utilities.
	Price Suppression	No	**Source:** Personal Communication with ETO Staff.
	Line Loss Costs	Yes	**Source:** ETO Methodology 2011.
	Reduced Risk	Yes	**Source:** Fifth Northwest Power Plan 2005; ETO Methodology 2011. **Note:** 10% credit for energy efficiency that acts as a "catch-all" for other avoided costs that aren't quantifiable. Specifically, this credit recognizes the benefits of conservation in addressing risk and uncertainty.
	Other Avoided Costs	Yes	**Source:** ETO Methodology 2011. **Note:** A range of risk avoidance values are applied from $5/MWh for discretionary programs to $10/MWh for lost opportunity programs. A 10% credit for energy efficiency that acts as a "catch-all" for other avoided costs that aren't quantifiable.
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** 10% credit for energy efficiency that acts as a "catch-all" for other avoided costs that aren't quantifiable.
	Program Administrator or Utility OPIs	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Participant or Customer OPIs:		
	Resource	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Low-Income	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Equipment	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Comfort	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Health & Safety	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Property Value	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Utility Related	Yes - 10% Adder	**Source:** ETO Methodology 2011. **Note:** Included in 10% adder.
	Societal OPIs	No	**Source:** Personal Communication with ETO Staff. **Note:** PUC only accounts for benefits to participants and the utility system.

Table A.8: Vermont

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		Least cost planning including environmental costs	**Source:** 30 VSA § 218c
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Societal Cost Test	**Source:** VT PSB 1990a, Section V.14.
	Other Test(s) considered (if applicable)	PAC, TRC	**Source:** Personal Communication with VT PSD Staff. **Note:** Efficiency programs are required to meet the Program Administrator test in order for the utility to receive a performance incentive. Further, 25% of the utility's performance incentive is based on the Total Resource Benefits achieved.
	Level at which Test(s) is applied	Portfolio	**Source:** Efficiency Vermont 2011, pp 3-5. **Note:** The decisive "test" under each perspective is the size of the net benefits, rather than the benefit/cost ratio.
	Other level(s) at which Test(s) is applied (if applicable)	Program, Project, Measure	**Source:** Efficiency Vermont 2011, pp 3-5. **Note:** Because cost-effectiveness of the portfolio is the primary objective, cost-effectiveness of any one component of the portfolio is secondary. The relative importance of cost-effectiveness of each component is hierarchical: (i) measure-level cost-effectiveness is subordinate to project-level cost-effectiveness; (ii) Individual measure- and project-level cost-effectiveness are subordinate to program cost-effectiveness; and (iii) Individual program cost-effectiveness is subordinate to overall portfolio cost-effectiveness.
	Discount rate used in Test(s)	Societal Discount Rate	**Source:** VT PSB 2012a, p 21. **Note:** Discount rate is 3% (real dollars), which is revisited as part of the biennial EEU avoided-cost proceedings.
	Study period over which Test(s) is applied	Measure Life	**Source:** Efficiency Vermont 2011, p 4; Personal Communication with VEIC and VT PSD Staff. **Note**: Cost-effectiveness is assessed over the near term (3 years or less) and longer term (3-20 years). However, 30 years is the maximum number of years allowed in the screening analysis, and there have been instances of even longer measures lives.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** VT PSB 2011. **Note:** Values from Synapse 2011.
	Energy Costs	Yes	**Source:** VT PSB 2011. **Note:** Values from Synapse 2011.
	T&D Costs	Yes	**Source:** VT PSB 2012b. **Note:** T&D working group established by VT Public Service Board.
	Environmental Compliance	Yes	**Source:** VT PSB 2011. **Notes:** Environmental compliance and "externality" values from Synapse's 2011 AESC Study are used for the Societal Cost Test. Externality values not used for TRB or PA tests.
	Price Suppression	No	**Source:** Volz, James, et al. **Notes**: Memo denies the use of price suppression effects for Vermont.
	Line Loss Costs	Yes	**Source:** Personal Communication with VEIC.
	Reduced Risk	Yes	**Source:** VT PSB 2012a, p 23. **Note:** Costs of efficiency measures are decreased by 10%, which will be revisited in the next biennial EEU avoided-cost proceeding.
	Other Avoided Costs	No	
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source**: VT PSB 2012a, p 26. **Note:** A 15% adder is applied to energy benefits.
	Program Administrator or Utility OPIs	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Participant or Customer OPIs:		
	Resource	Yes - 15% Adder	**Source:** VT PSB 2012a. **Note:** Water and fuel savings and benefits are directly calculated, separate from the 15% adder.
	Low-Income	Yes - Additional 15% Adder	**Source:** VT PSB 2012a, p 33. **Note:** An additional 15% adder is applied to the energy benefits of the low-income sector.
	Equipment	Yes - 15% Adder	**Source:** VT PSB 2012a. **Note:** Changes in O&M expenses by measure are directly calculated, separate from the 15% adder.
	Comfort	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Health & Safety	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Property Value	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Utility Related	Yes - 15% Adder	**Note:** Included in the 15% adder.
	Societal OPIs	Yes - 15% Adder	**Source:** VT PSB 2011. **Note**: Included in the 15% adder.

Table A.9: Wisconsin

Cost-Effectiveness Metrics		Policies & Practices	Notes & Sources
Primary Policy Driver		All cost-effectiveness energy efficiency up to funding cap	**Source:** Personal Communication with WI PSC Staff.
Cost-Effectiveness Test(s) & Application	Primary Test used by state	Modified Total Resource Cost Test	**Source:** Cadmus 2012, p 48; WI PSC 2010. **Note**: The TRC is used because it is "consistent with the Commission's focus on energy use and peak demand reduction." Michigan refers to its primary cost-effectiveness test as the modified TRC to distinguish it from the expanded TRC test, which is also used in cost-effectiveness screening.
	Other Test(s) considered (if applicable)	PAC, Expanded TRC	**Source:** WI PSC 2010. **Note**: "the modified TRC test does not provide useful guidance for appropriate program design, so the Commission finds it reasonable to require that programs must pass the Utility/Administrator test in order to ensure that the benefits ratepayers receive from these programs exceed the programs' costs." "The Commission recognizes that other non-economic externalities are also significant, so the Expanded test must also be applied at the portfolio level."
	Level at which Test(s) is applied	Portfolio	**Source:** WI PSC 2010, pp 7-8.
	Other level(s) at which Test(s) is applied (if applicable)	Measure, Program	**Source:** WI PSC 2010, p 7; Personal Communication with WI PSC Staff.
	Discount rate used in Test(s)	Low-Risk	**Source**: Cadmus 2012, p 49; WI PSC 2010. **Note**: The low-risk discount rate represents the public sector cost of borrowing. It also provides an appropriate balance between the benefits of current ratepayers and benefits of future ratepayers. It is current set at 2% by the MI PSC.
	Study period over which Test(s) is applied	Measure Life	**Source:** Personal Communication with WI PSC staff.
Avoided Costs Included in Cost-Effectiveness Test(s)	Capacity Costs	Yes	**Source:** Cadmus 2012, p 48; WI PSC 2010. **Note:** Avoided capacity costs based on the cost of a new peaking plant.
	Energy Costs	Yes	**Source:** Cadmus 2012, p 48; WI PSC 2010. **Note**: Avoided energy costs are based on the most recent three-year historical average of locational marginal prices.
	T&D Costs	No	**Source:** Cadmus 2012; Personal Communication with WI PSC Staff. **Note**: It is included in the line losses calculation, but significantly undervalued.
	Environmental Compliance	Yes	**Source:** Cadmus 2012, p 49. **Note**: Emissions Benefits for CO2, NOx, and SOx. A levelized carbon value of $30/ton is reasonable.
	Price Suppression	No	**Source:** Personal Communication with WI PSC Staff.
	Line Loss Costs	Yes	**Source:** Cadmus 2012, p 49; WI PSC 2010. **Note:** Line loss factor of 8%.
	Reduced Risk	No	**Source:** Personal Communication with WI PSC Staff.
	Other Avoided Costs	No	**Source:** Personal Communication with WI PSC Staff.
OPIs/NEBs Included in Primary Cost-Effectiveness Test	Are OPIs included in Primary Test(s)?	Yes	**Source:** WI PSC 2010. **Note**: Only gas benefits are included in the modified TRC. No other OPIs are included in the modified TRC test, although the expanded TRC test does included additional OPIs.
	Program Administrator or Utility OPIs	No	
	Participant or Customer OPIs:		
	Resource	Yes	**Source:** Cadmus 2012, App. I. **Note**: Includes gas benefits only.
	Low-Income	No	
	Equipment	No	
	Comfort	No	
	Health & Safety	No	
	Property Value	No	
	Utility Related	No	
	Societal OPIs	No	

Appendix B – Best Practices on Select Issues

Introduction

As a fundamental principle, the costs and benefits included in a state's energy efficiency screening test should be consistent with the state's policy objectives, because these objectives provide guidance on the value that a state might place on energy resources. The list of relevant policy objectives to use for efficiency screening may be unique to each state. Some of the key policy objectives that have been established in states include, for example, reduce costs to electric customers, achieve all cost-effective energy efficiency, reduce market barriers to energy efficiency, promote economic development, and reduce environmental impacts.

The public policy goals in each state have a large impact on the states' decisions with regard to cost-effectiveness screening details. For example, Vermont has an explicitly stated goal of reducing the cost of electricity generation, including environmental costs, and therefore has chosen to use the Societal Cost test. These different policy objectives apparently explain some of the key differences between the cost-effectiveness practices across states.

There are certain key energy efficiency screening practices that may be appropriate for all states, or that may be appropriate for all those states that have chosen to utilize a particular test. The following best practices are based on the premise that sound screening practices should (a) generally meet the state's energy policy goals, (b) use a screening test that is consistent with the state's energy policy goals, (c) apply the chosen screening test in a way that is internally consistent, (d) use methodologies that are consistent with the perspective of the chosen test, and (e) account for all the costs and benefits that are relevant to the chosen test.

Other Program Impacts

It is best practice to include OPIs in cost-effectiveness tests for which the relevant costs and benefits are applicable. If any one test includes some of the costs (or benefits) from one perspective, but excludes some of the costs (or benefits) from that same perspective, then the test results may be skewed; i.e., they may not provide an accurate indication of cost-effectiveness from that perspective. (Synapse 2012b; Neme and Kushler 2010).

Therefore, if a state has chosen to use the TRC test as the primary screening test, then it would be more internally consistent for the state's cost-effectiveness analysis to include utility- and participant-perspective OPIs. The TRC test includes all the costs to program participants, and therefore it should also include all the benefits to program participants in order to maintain internal consistency. Otherwise the test results may be inherently skewed against energy efficiency. (RAP 2013, pp 13-14).

For similar reasons, if a state has chosen to use the Societal Cost test as the primary screening test, then it should include utility-, participant-, and societal-perspective OPIs.

If a state chooses not to account for OPIs, then the state would benefit from using the PAC test, as the test results would be more internally consistent. Otherwise, if a state uses the TRC or Societal Cost test without including OPIs, then the state may undervalue energy efficiency, which may result in customers paying higher costs than necessary for energy services.

Ideally, states should establish quantitative, monetary values for all relevant OPIs. There are, however, several challenges and uncertainties associated with developing monetary estimates of some OPIs. Some of the OPIs may be unique to certain customer types, and some of the OPIs may depend upon the unique preferences or conditions of different customers. Under even the best of circumstances it is difficult to ensure that all relevant OPIs are accounted for, and that their magnitudes are properly assessed. These challenges can be one of the biggest barriers that hinder states' willingness and ability to account for OPIs.

Given the large number of OPIs, and the difficulty in measuring and accounting for all of them, it may be helpful for regulators to prioritize the impacts to identify those that are most likely to affect the outcome of the energy efficiency cost-effectiveness screening. For example,

- Utility-perspective OPIs are generally considered to be small relative to other OPIs. However, some studies have identified significant benefits associated with reduced shutoffs and reconnects, as well as bad debt write offs and carrying costs on arrearages. In addition, utility-perspective OPIs can be significantly larger for low-income customers, particularly in states where low-income customers are offered discounted rates or shutoff protection provisions that can sometimes result in large arrearages.
- Participant-perspective OPIs have been found to be particularly significant and thus have important implications for screening efficiency resources with the TRC test. While there is a wide range of potential participant-perspective OPIs, the ones that are used most frequently in energy efficiency screening can be categorized as follows: resource benefits (e.g., water or other fuel savings), low-income benefits; equipment operations and maintenance costs; health and safety; comfort; property value; and utility related benefits.
- Many of these participant-perspective OPIs are particularly large for low-income customers, because of the conditions of their dwellings, the other demands on their limited resources, and other hardships they may face. In addition, low-income energy efficiency programs are often less cost-effective than other efficiency programs because the customers are harder to reach and the barriers are more difficult to overcome. Consequently, regulators frequently place a higher priority on the participant-perspective OPIs that apply to low-income efficiency programs.
- Societal-perspective OPIs can be quite large and also can be challenging to develop quantitative estimates for. The reduction of greenhouse gases from the electricity industry is frequently considered among the more significant societal benefits, and there are studies available to provide guidance as to their magnitude (see Synapse 2013). The economic development benefits of energy efficiency resources are also considered to be significant, and there are studies available to provide guidance as to their magnitude (see ENE 2009).

It is important to avoid giving greater priority to those impacts that are readily measurable and quantifiable simply because they are easier to obtain. The utility-perspective OPIs tend to be relatively easy to quantify, but they also tend to be low in value. Conversely, some participant-perspective NEIs can be difficult to quantify, but are expected to be quite large.

States that do not currently have estimates of quantitative monetary values for OPIs could take the following steps to develop such estimates:

1. Identify all of the OPIs that are likely to have a significant impact on the costs and benefits of the energy efficiency programs, based upon the energy efficiency programs offered, and the screening test used, in the state.
2. Develop quantitative estimates for all OPIs that can be readily quantified. At a minimum, this could include the other fuel and resource savings, because these savings can be relatively easily quantified using forecasts of the prices for those fuels.
3. Develop some methodology for addressing those OPIs that are not quantified, e.g., by using an adder to the benefits as a proxy for the OPIs. For example, if the state does not develop quantitative estimates for the low-income NEBs, then at a minimum these benefits could be addressed through some proxy approach.[13]
4. Undertake independent analyses to develop the best state-specific OPI estimates possible. The money required for this type of research could come from program administrator’s evaluation, monitoring and verification budgets.

While it may be difficult to quantify or otherwise prioritize values for OPIs when applying the Societal Cost test or the TRC test, using the best estimates available is a significant improvement over using no estimates at all. Again, states that are unwilling or unable to account for a reasonable range of OPIs would benefit from using the PAC test to screen efficiency resources instead of the TRC test.

Price Suppression Effects

Energy efficiency resources provide benefits through wholesale market price suppression effects in regions with competitive wholesale electric markets. Even a small reduction in a market clearing price can result in significant cost reductions across the entire market. The price suppression effects act as a benefit because it represents a reduction in costs to wholesale electric customers, which are passed on to retail electric customers. Therefore, cost-effectiveness results from the PAC test, the TRC test, and the Societal Cost test would be more accurate if they included benefits associated with price suppression.

Some states do not account for the price suppression effects on the grounds that these effects will dissipate over time as the wholesale electricity market naturally adjusts to the new level of demand on the system. While it is true that the wholesale electricity market will naturally adjust in this way, it will take several years to do so. During that time there will be a real reduction in wholesale electricity market prices as a result of the energy efficiency savings, and those reductions will represent real

[13] One way to determine an adder to apply to program benefits is to review the benefits used in neighboring states that quantify OPIs. For example, in Massachusetts, the non-resource benefits on a statewide basis make up approximately 17% of total benefits in 2013. Another way to account for OPIs without knowing the exact value of the benefits is to allow programs to be implemented even if they do not have a benefit-cost ratio greater than 1.0, with the understanding that there are benefits that would make the program cost-effective if they could be quantified more easily.

savings to electricity customers. Cost-effectiveness test results would better account for all energy efficiency resource benefits if states ensured that estimates of the price suppression effect account for the dissipation of this effect, rather than simply excluding the price suppression effect altogether.

It is sometimes argued that the price suppression effect should not be considered a benefit to energy efficiency programs because it is a "transfer payment" from generators to electricity customers. As such, the benefit to electricity customers is equally offset by a cost to the generators. While it is true that the effect results in reduced profits to generators, this does not mean that the reduced profits should be netted out against the reduced cost to customers. Profits are not considered a transfer payment. Instead, they are a part of the cost of a resource; in the same way that the cost of capital, which includes an element of profit, is typically considered a part of the cost of a supply-side resource. The reduction in generator profits is simply the equivalent of a reduction in cost for the resource. Therefore, cost-effectiveness results from the PAC test, the TRC test, and the Societal Cost test may better account for all energy efficiency resource benefits by including benefits from the price suppression effect.

Reduced Risk

Most states do not recognize that energy efficiency may reduce risks on the utility system associated with supply-side resources. States could consider explicitly accounting for the risk benefits of energy efficiency, given the potential value of reduced risk and the many ways that energy efficiency can reduce utility system risks.[14] There are three types of risks related to utility system resource planning: financial risk, project risk and portfolio risk.

Financial risk refers to the risk associated with the funding (i.e., the cost of capital) used to invest in the supply-side or demand-side resource. When an energy efficiency program administrator uses a system benefit charge, or some other fully-reconciling charge, to fund energy efficiency there is a very low financial risk (i.e., low cost of capital) to the utility or the program administrator. In these cases, energy efficiency resources have a lower financial risk than supply-side resources.

Project risk refers to the risks associated with planning, constructing and operating the resource, or, project. Efficiency resources are typically much less risky than supply-side resources that have risks associated with construction costs, fuel price volatility, swings in electricity demands, market volatility and other market risks (Ceres 2012). While energy efficiency resources have project risks of their own, these tend to be significantly lower than those associated with supply-side resources, particularly for those states that have been operating efficiency programs for a sufficient period of time to establish stable programs and develop enough historical data to be able to make reasonable predictions of program participation and results. Therefore, energy efficiency resources typically have lower overall project risk than supply-side resources.

[14] See, for example, Ceres 2012, which includes a detailed discussion of risks associated with electricity resources, and explains why energy efficiency has lower risks than all other electricity resources.

Portfolio risk refers to the risk experienced by an investor from the total portfolio of investments, projects, or resources. Different combinations of investments, projects or resources will result in different types of risks for the investor. One common practice for reducing portfolio risk is to diversify investments. Energy efficiency can help diversify a utility system resource mix. Therefore, energy efficiency resources can generally help reduce portfolio risk.

Risk benefits can be accounted for in several ways when screening energy efficiency resources (RAP 2013, pp 41-42). For example:

- A risk adder can be applied to the energy efficiency benefits, as a proxy for the risk benefits. This approach is used by Vermont and Washington DC.
- The discount rate can be selected, or adjusted, to account for the risk benefits of energy efficiency. Several states in our survey apparently use this approach.
- In states that use integrated resource planning (IRP) to determine the appropriate level of energy efficiency resources to implement, risk assessment modeling techniques can be used to assess risks associated with different resources and resource portfolios.

The choice of discount rate (addressed in the next section) is likely the best way to reflect the risk benefits of energy efficiency for a state. The discount rate is likely the best approach to addressing *financial* risks, because the discount rate is intended to account for the time value of money. The discount rate is also better suited to reflect *project* risk and *planning* risk than a proxy benefits adder. A proxy adder for risk benefits simply increases the avoided costs equally across all years, while a risk-adjusted discount rate will affect the value of costs and benefits over time commensurate with the risks associated with time.

While a proxy adder for risk benefits is a reasonable way to approximate the risk benefits of energy efficiency, the choice of discount rate provides a better option for accounting for risk. This option is discussed in more detail in the following section.

It is important to ensure that risk benefits are neither undervalued nor double-counted. For this reason, when states apply risk benefit adders and/or risk-adjusted discount rates they should consider explicitly identifying the extent to which each mechanism is meant to address financial risk, project risk, portfolio risk, or some combination of these risks.

Discount Rate

Discount rates are commonly used to compare future streams of costs in a consistent way, by estimating the present value of the costs and expressing them in a common reference year. The choice of discount rate will have a significant impact on the present value of costs and benefits; relatively high discount rates will significantly reduce the value of costs and benefits in the later years of the study period, while relatively low discount rates will reduce that value by much less. A discount rate of zero means that costs and benefits in future years are valued as much as costs and benefits today. The choice of discount rates is especially important for energy efficiency resources, whose costs are typically incurred in early years while benefits are experienced in later years. (RAP 2013, p 19).

Discount rates are used to account for two concepts: the time value of money and the riskiness of the investment (Synapse 2012b).[15] The time value of money is captured in the cost of capital that an investor uses to finance an investment; and the cost of capital is one of the key determinants of the discount rate. The riskiness of an investment is an indication of the project risk and or portfolio risk; and those investments that are expected to have a low project risk or portfolio risk can be discounted using a relatively low discount rate to reflect that risk.

It is best practice that the discount rate used for efficiency screening reflect the relatively low financial risk of the energy efficiency programs. Energy efficiency programs financed by a system benefits charge, or a similar fully-reconciling charge, would provide cost-effectiveness test results that are more internally consistent if states used a low-risk discount rate to reflect the low financial risk of the funding source. A low-risk discount rate could, for example, be based on a general indicator of low-risk investments, such as US Treasury bonds.

Also, when screening energy efficiency resources states could consider using risk-adjusted discount rates to reflect the low project and portfolio risks associated with energy efficiency. This would mean reducing the discount rates, to a level below the discount rate that is chosen solely on the basis of the cost of capital. Therefore, a state that uses a system benefits charge, or similarly reconciling charge, could start with a low-risk discount rate based on the cost of capital, and then adjust it downward to reflect the project and portfolio risk reduction benefits.

In some cases, a state will choose a discount rate based on the cost-effectiveness test. For example, in Vermont and Washington DC the societal discount rate is chosen because the state has chosen to use the Societal Cost test to screen energy efficiency. While there is sound logic in applying a societal discount rate when using the Societal Cost test, it is not entirely clear what the societal discount rate represents in these cases. First, there is a range of discount rates that could be used to reflect society's perspective. Second, it is not clear to what extent this choice of discount rate is intended to account for reduced financial, project and/or portfolio risk.

Finally, it is important to note that the choice of discount rate is essentially a policy decision. In addition to the considerations described above, states could consider choosing a discount rate that is informed by the weight the regulators wish to give to the future benefits of energy efficiency programs. At a minimum, each state's cost-effectiveness test results would be more internally consistent if the state explicitly identified what objectives it is trying to achieve with its choice of discount rate, and ensured that the choice of discount rate is consistent with these objectives.

[15] Discount rates can also be used to account for inflation. In this report, we refer to "real" discount rates, which should be applied to "real" or "constant" dollars.